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The Effect of Eight Weeks of Aerobic Training on Indices of Cardio-Respiratory and Exercise Tolerance in Overweight Women with Chronic Asthma

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***Abstract*—**Asthma, obesity and overweight are the main factors causing change within the heart and respiratory airways. Asthma symptoms are normally observed during exercising. Epidemiological studies have indicated asthma symptoms occurring due to certain lifestyle habits; for example, a sedentary lifestyle. In this study, eight weeks of aerobic exercises resulted in a positive effect overall in overweight women experiencing mild chronic asthma. The quasi-experimental applied research has been done based on experimental and control groups. The experimental group (seven patients) and control group (n = 7) were graded before and after the test. According to the Borg dyspnea and fatigue Perception Index, the training intensity has determined. Participants in the study performed a sub-maximal aerobic activity schedule (45% to 80% of maximum heart rate) for two months, while the control group (n = 7) stayed away from aerobic exercise. Data evaluation and analysis of covariance compared both the pre-test and post-test with paired t-test at significance level of P≤ 0.05. After eight weeks of exercise, the results of the experimental group show a significant decrease in resting heart rate, systolic blood pressure, minute ventilation, while a significant increase in maximal oxygen uptake and tolerance activity (P ≤ 0.05). In the control group, there was no significant difference in these parameters ((P ≤ 0.05). The results indicate the aerobic activity can strengthen the respiratory muscles, while other physiological factors could result in breathing and heart recovery. Aerobic activity also resulted in favorable changes in cardiovascular parameters, and exercise tolerance of overweight women with chronic asthma.

***Keywords*—**Asthma, respiratory cardiac index, exercise tolerance, aerobic, overweight.

I. Introduction

CHRONIC respiratory diseases have been significantly growing in industrial societies resulting in disability and death of the population. Bronchial asthma is known as one of the common chronic respiratory disorders which has symptoms like obstruction or inflammation of the air passages and hyperactivity of bronchioles [1]. Allergic asthma originates physiologically from airways, by narrowing them. Regarding to the clinical perspective, asthma starts with sudden attacks of shortness of breath, coughing, and wheezing [2]. Increasing the strength of the respiratory tract in patients with asthma is corresponding to reducing the function of the lung [3]. In addition, narrowing the airways reduces the amount of oxygen in the bloodstream hence, reduces the readiness of cardio vascular diseases and respiratory disease [4]. Today, there are 300 million asthma patients, and 2025 asthma patients in the world are forecasted; in fact, 100 million people will be added [5]. The prevalence of asthma in Iran is currently at a medium level which fluctuates between 5% and 15% of approximately 5.6 million people [3]. Cross-sectional studies have shown that obesity is observed with the prevalence of asthma and with an increased risk of asthma severity [6], [7]. The smooth muscle causes the narrowing of the airways while the adipose tissue leaves immunological effects [8]. Some researchers have reported that asthma has a avascular relationship with heart disease since, the release of mediators of asthma leads to different vasoconstriction of the pulmonary arteries. As a result, the pulmonary blood pressure leads to right ventricular enlargement and dysfunction of the heart, known as cardiac failure. These incidents can cause respiratory symptoms [9]. In other words, one out of three patients tend to have normal respiratory symptoms towards participating in 10 to 20 recovery sports [10]. In particular, these studies have implicated into reducing daily physical activity. The submaximal aerobic exercise as an anti-inflammatory agent protects against the risk factors of disease. The role of ischemic heart disease and metabolic syndrome or lung disease has been reported [11]. However, American College of Sports Medicine (ACSM) and American Thoracic Society (ATS) offer a sport plan three to five times a week for 30 minutes in the form of walking, running, swimming, and riding a bike with the tense of 50% to 60% of oxygen intake assisting the lungs [12], [13]. However, few studies exist that shows relationship between patients and healthy people with respect to fitness of the heart and lungs [14], [15]. Generally, beside clinical procedures, drug usage is a common treatment.

II. Materials and Methods

The study was done in 2015 with population of 458 patients with mild asthma. All patients were referred to the clinic of Imam Khomeini Hospital in Ahwaz with a breathing disorder. By screening the patients' medical records by specialist, 58 patients were diagnosed with mild asthma eligible to

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participate in the research. The physical examination data were recorded. Twenty six people were interested to participate in the voluntary scheme and in the sports activities; and their oral and written consent was signed according to ethics. Inclusion criteria for the study subjects were women with asthma aged 30 years to 50 years, being diagnosed at least within two years, not already participating in regular physical activity during the past six months, having a body mass index (BMI) of over 25 (kg/m^2), non-smoker and non-drinker patients, and with no history of cardiovascular or kidney disease, high blood pressure, or musculoskeletal disorders. Participants must be diagnosed with only mild to moderate asthma and having not experienced a relapse for a period of at least three months. Exclusion criteria within the control group: experiencing an attack during exercise or at hospital, having a severe degree, inability to enforce or exercise deep breathing, and inability to change the dose of prescription medicine. Then, cane test programs were identified; there were 14 patients with a continuous presence. The subjects got familiar with the purpose and process of the rehabilitation projects and signed a written informed consent. The subjects were randomly divided into two groups: experimental and control.

III. Data Registration

Cardio respiratory data were examined in two pre-test and post-rest stages in the same condition, two days before and two days after aerobic protocol was performed at a particular hour. To measure body fat percentage and BMI, the Body Composition Analyzer device and Model 3/3 Olympia made by the Jawon Company of South Korea were used. Resting heart rate in beats per minute was measured using a Beurer digital thermometer bearer PM 80 model made in Germany. Blood pressure was measured using a mercury manometer. Peak of oxygen consumption was measured indirectly through a Rockport test. Minute ventilation was measured by Gas Analyzer System (model QUARK b2 Manufacturing Co. COZMED Italy). All were measured and recorded through a for the one minute test. One minute ventilation was achieved from the product of tidal volume and respiratory rate per minute. Therefore, increased respiratory rate can increase the one minute ventilation and reduce the partial pressure of carbon dioxide. On the other hand, the changes in the breathing rate causes fixed ratio of Inspiratory and Expiratory (I/ E ratio) and this usually cannot change MAP (The average airway pressure) and do not have so much impact on PaO2. Therefore, respiratory rate and short expiratory time are often poorly tolerated. The common examples of these diseases are respiratory distress syndrome (RDS), which usually use about 60 breaths per minute, and the recommended brewing time between 0.3 - 0.4 seconds. Brewing time higher than 0.5 seconds and shorter than 0.2-0.3 seconds is not recommended. Totally, respiratory rate is mostly between 40 minutes to 60 minutes on clinical scenarios. Also, to measure the tolerance to activity-based instruction, American Thoracic Union Test 6 Minute Walking Test (6MW) introduced a standard test for respiratory disease. The test is on the shuttle back and forth of a 15 m track of MILEAGE and it was measured and recorded by an examiner. Also, according to the provisions of this test, the patients run the motor activity completely freely for six minutes at a fast pace before the end with six minutes of rest between activities [16]. To determine chronic asthma, in addition to the patient's medical records, a physical examination by a board asthma and allergies of Spirometry measured and recorded the resistance index lumen of the trachea at the first second (FEV1) during the two stages before and after the test. In addition, according to astute opinions, the participants were asked to use Bronchioles vasodilator drugs a few hours before each training session to prevent an asthma attack.

IV. Training Program

Participants in the study began with a warm up session 10 min prior to the start of Test. The warm up exercises included respective aerobic exercises like fast walking and jogging and then stretching and dynamic, static, and kinetic movements. Group exercises focused on aerobic exercises to increase activities and Borg activities in the form of brisk walking and running alternatively. Components in the first week of each training session included 15 min of aerobic exercise at 45% of maximum heart rate with an intensity of five sets which reached to 30 min of aerobic exercise at 80% of maximal heart rate and 12 alternates at the eighth week. The work to rest ratio was 2:1 in the first week, which reached to 1:1/5 at the eighth week. The intensity of workouts based on heart rate and breast heart-rate were controlled. Thus, the intensity of the program has been calculated based on the results of Polar heart-rate and the patients were informed. The moderate intensity exercise included - exercise time of 15 min in the first session to 30 min until the end of the session for increasing the workout time. To control the intensity safety of the exercise, some physiological signs including heart rate training and Borg practiced severity index were considered. During the initial stages of the exercise regime, equipment including an oxygen machine, with a physician assistant present. To relax the intensity of the exercise, the protocol of active rest was used during movement, stretching, and walking. The participants' heart rate dropped below 35-40% of maximum heart rate (Table I).

At the end of each training session, sitting static stretching exercises to cool down and recovery were done. In these exercises, all the muscles involved in the training experienced pressure, which was maintained for 8 seconds. Cooling down time was about 10 min at the end of each training session. After reviewing the data distribution (Shapiro test Wilkes) and adhering to the default variance consistency of the two groups (Levine test), data were analyzed through the 17th version of the SPSS software at the significant level of $p \leq 0.05$. Also, the paired t-test and analysis of covariance examined the changes from the pre-test to post-test and differences between the test and control groups.

V. Results

According to the results, the subjects of the experimental and control groups were not significantly different in terms of demographic variables, age, weight, height, body fat percentage, and BMI (Table I).

Descriptive statistics with mild and moderate asthma are shown in Table II.

TABLE I
EXERCISE COMPONENT IN MODERATE AEROBIC TRAINING PROTOCOL FOR CHRONIC ASTHMA

Step Workout	Work intensity% HR_{max}	The number of rotations	Work to rest ratio	Original duration (min)	Time (Activities +Warming up &cooling down) (min)
First week	45	5	1: 2	15	35
Second week	50	6	1: 2	18	38
Third week	55	7	1: 2	21	41
Forth week	60	8	1: 1.5	20	40
Fifth week	65	9	1: 1.5	22.5	42.5
Sixth week	70	10	1: 1	20	40
Seventh week	75	12	1: 1.5	30	50
Eighth week	80	12	1: 1.5	30	50

TABLE II
PHYSICAL INDICATORS OF THE EXPERIMENTAL AND CONTROL GROUPS

Post-exam M ± SD	Pre-exam M ± SD	Group	Variable
_	37.85 ± 9.56	Experimental	Age (years)
_	36.14 ± 9.77	Control	
68.74 ± 8.17	70.75 ± 8.89	Experimental	Weight (kg)
72.9 ± 8.37	72.68 ± 8.66	Control	
_	157.14 ± 5.30	Experimental	Height (cm)
_	156.42 ± 6. 34	Control	

Also clinical and physiological parameters in experimental and control groups have been prepared in Table III.

Analysis of variance of groups revealed that cardio respiratory indicators of experimental groups including resting heart rate, systolic, maximum oxygen consumption, minute ventilation, and activity tolerance (6 min walk) improved significantly after aerobic exercise protocol ($p \leq 0.05$), while in some cases in the intergroup control group, there was no significant difference. Also, the analysis of the experimental and control groups show that variables of resting heart rate, systolic, maximum oxygen consumption, ventilation minute, and activity tolerance (6 min walk) improved significantly after aerobic exercise protocol ($p \leq 0.05$). The results are provided in Table IV.

VI. Discussion

The two months of aerobic exercise protocol were accompanied by improvements in heart index, respiratory and activity tolerance including resting heart rate, systolic, maximum oxygen consumption, minute ventilation, and 6-minute walk test. Changes in lifestyle, low-volume daily physical activity, body composition and fat, high-fat diet preparation, concentration of naturally occurring and synthetic are the confounding parameters likely to spread and exacerbate the symptoms of asthma [17]. Sex may be an important and influential factor associated with obesity and pulmonary function so that obesity before puberty, especially in boys may reduce lung growth [18].

One of the biggest limitations of this survey was lack of access to the articles of the related group. The researchers explored the ongoing and numerous scientific resources and academic sites of libraries, but did not find any consistent study with the current one. Cross-sectional studies in women showed an association between asthma and obesity, and the men in prospective studies showed no clear association between asthma and obesity. On the other hand, the satiety hormone leptin produced by fat tissue and having influence on immune cells and inflammation can lead to the development of asthma. Among men and women with equal BMI, the leptin levels of women are recorded higher than men. Thus, it seems that the association between asthma and obesity in women is clearer than in men [19].

Heart rate is one of the simple parameters that provide important information in relation to cardiovascular diseases. This study significantly reduced the resting heart rate in patients with asthma who had previously inactive lifestyles. Several studies have shown that doing regular exercising would reduce the symptoms of asthma or reduce the chances of developing or having an attack. The increase in respiratory muscles result in improving Spiro metric indices that eventually enhances lung function in patients with asthma. Ultimately, it leads to increase in maximum oxygen consumption as a cardio respiratory indicator [20]. A three-month exercise program led to a significant reduction in heart rate and an increase in peak oxygen consumption in children with asthma while running at the time [21]. In one study, Freeman et al. showed that endurance exercise caused a significant reduction in the heart rate of a group of patients with asthma. It seems that the reduction in heart rate was due to an increase in stroke volume and a decrease in peripheral resistance [22]. Thus by participating in an exercise regime, especially low intensity aerobic exercise for 30 min per session is recommended; 40% of maximal oxygen uptake in the initial sessions and then an increased severity for cardio respiratory fitness in these patients was recorded [23]. In addition, obesity also increased the risk of asthma through genetic, hormonal, and neurological or mechanical effects [19].

TABLE III
CLINICAL INDICES OF EXPERIMENTAL AND CONTROL GROUPS

Post-exam M ± SD	Pre-exam M ± SD	Group	Variable
27.98 ± 4.2	29.7 ± 4.23	Experimental	BMI (kg/m^2)
29. 89 ± 2.59	29.65 ± 2. 53	Control	
33.71 ± 3.62	35.61 ± 3.57	Experimental	Fat percentage (percent)
38.57± 2.54	38. 85± 2.39	Control	
3.77±4.61	32.32± 5.41	Experimental	Peak oxygen consumption (ml per kilogram per minute)
32. 62 ± 7. 69	32.76± 8.17	Control	
89.41± 12	86.71± 16	Experimental	Percent of the maximum inspiratory flow rate again in the first second (FEV1 0/0)
83. 47± 11	82.42± 10	Control	

TABLE IV
PARAMETERS CHANGES (AVERAGE AND STANDARD DEVIATION) FOR THE STUDY OF THE CONTROL AND EXPERIMENTAL GROUPS

External group changes		Internal group changes		Post-exam	Pre-exam	Group	Variable
t	sig	F	sig	M ± SD	M ± SD		
3.24	0.01*			76.85 ± 6.96	82.71 ± 8.93	Experimental	Heart beat
0.34	0.73	10.84	0.007 *	80.85 ± 4.37	81 ± 4.54	Control	(Bpm)
8.41	0.001*			113.71 ± 2.4	122.71 ± 2.92	Experimental	Blood pressure
-0.66	0.53	13.36	0.004*	122.85 ± 7.38	121.14 ± 5.69	Control	(MmHg)
-4.99	0.002 *			34.77 ± 4.61	32.32 ± 5.41	Experimental	VO_{2max}
0.42	0.68	25.94	0.001*	32.62 ± 7.69	32.76 ± 8.17	Control	(Ml.kg^{-1} .min^{-1})
10.48	0.001 *			13.24 ± 1.79	14.15 ± 1.85	Experimental	Ventilation per minute
0.83	0.43	32.77	0.001*	13.28 ± 2.24	13.37 ± 2.23	Control	(L/ m)
-4.17	0.006*	32.82	0.001*	712 ± 85.44	554 ± 23.91	Experimental	6MWT (m)
-2.09	0.08			540.42 ± 24.58	538.85 ± 23.14	Control	

*Significant level ($p \leq 0.05$)

Changes in the breathing patterns of obese individuals will change the elasticity function of smooth muscles. Increased secretion of adipocytes and inflammatory mediators such as TNFa, IL-6, Ataxic, and Leptin and their reductions in contrast, anti-inflammatory adipocytes such as IL-10 are effective in the prevalence and severity of asthma symptoms and airway inflammation of obese individuals. Obesity is also associated with insulin resistance which can be associated with the development of asthma symptoms. The basic relationship between adipocytes serum of asthma patients and decreased lung function with insulin resistance confirmed that despite the close relationship between obesity and insulin resistance, the role of adipocytes as an anti-inflammatory cytokines in the asthma's indicator is independent on the insulin resistance [19]. On the other hand, in many parts of the world, asthma and high blood pressure have increased dramatically in the past few decades [24]. Recently, asthma was found to be related to cardiovascular diseases and associated risk factors such as high blood pressure. A study in Canada showed the population with asthma, it indicated the women who are diagnosed with cardiovascular diseases and related risk factors in hypertension are more likely to struggle with having asthma. Another Canadian study showed that 36% of asthmatic patients have higher blood pressure in comparison with non-asthmatic patients [25]. This study resulted in a higher reduction in the systolic blood pressure of theaerobic exercise group in comparison with the control group. This study is consistent with [26]-[28]. The findings of randomized controlled experiments on the effects of aerobic exercise showed that exercise can reduce blood pressure in people with normal blood pressure or people exposed to high blood pressure. The sympathetic nervous system and renin-angiotensin are involved in reducing blood pressure by decreasing the SVR (systemic vascular resistance). The reduction in sympathetic nervous system activity and the kidneys are the strongest long-term factors affective in the regulation of blood pressure [28].

The consistency of the physical activity is directly related to the quality of the respiratory tract that ultimately leads to increasing threshold ventilation and reducing pulmonary ventilation during measurement. Thus, the function of the main and auxiliary respiratory muscle can reduce the wheezing and dizziness, which triggers asthma during sports [29]. In this survey, the minute ventilation in the exercise group decreased significantly compared to the control group, which is in accordance with [30]-[34], which showed that a sustained exercise with a particular intensity activity can supply adequate ventilation. In addition, it can cause a physiological recovery after doing exercises with oxygen consumption. This adaptation of metabolism to aerobic exercise is important, especially for patients with asthma. On the other hand, airway obstruction during exercise in patients with asthma is associated with an increase in activities of the inspiratory muscle, which happens in the air flow resistance and dynamic hyperinflation of the lungs and increases the ending of expiratory of lung volume. It is clear that hyper activity breathing for dynamic inflation is an important factor facing shortness of breath for asthma individuals. It increases the impaired properties of the contraction of the respiratory muscles. Raised breathing is also accompanied with an increased risk of fatigue of the inspiratory muscles which may cause shortness of breath and reduced exercise tolerance.

Accordingly, it is reasonable that inspiratory muscle strength in people with asthma may be associated with reduced breathlessness and improved exercise tolerance [35]. The results regarding of significant improvements in 6-min walk distance in the exercise group compared to the control group are in accordance with [31], [36]-[38]. Freud et al. examined the effects of an eight-week aerobic exercise program on lung function and activity tolerance in patients with asthma. The 6-min walk test was used for assessing the tolerance activities of patients, and changes in the 6-min walk were significant too. Thus, intensity and duration were factors affecting this program.

The physiological benefits that occur through sports programs may improve exercise tolerance in patients. In healthy people, exercise results in changes in muscles, and as a result, improved oxygen delivery to the metabolism, and potentially preventing the onset of lactic acidosis [39]. It is important to note that doing exercise may have different feedbacks depending on respiratory reactions. Remodeling of the respiratory tracts refers to the extensive patterns of pathophysiological mechanisms including smooth muscle cell hyperplasia, increase in fibroblast activity, myofibroblasts, and deposition of the extracellular matrix. Pulmonary parenchymal tract in conditions such as age, physical activity, and various diseases such as asthma, fibrosis, Chronic Obstructive Pulmonary Disease (COPD), acute respiratory distress syndrome, respiratory distress, syndrome, ARDS), chronic bronchitis, and allergies will face different circumstances on lowering respiratory tracts [40].

The study was carried out under the title of the impact of exercise on upper and lower extremities in respiratory capacity of patients with asthma. The reduction of shortness of breath in the asthma groups (exercise in the upper-lower and hybrid limbs) and considering the physical activities showed significant differences in dyspnea reduction. Also, a significant improvement has been reported in oxygen consumption of the three experimental groups [41].

VII. Summary and Conclusion

In conclusion, according to studies in the field of asthma, it was found that several factors can cause asthma including obesity and overweight. Therefore, exercises can help to control asthma and reduce its symptoms through weight reduction and the strengthening of respiratory muscles. According to the studies conducted on patients with mild asthma the mild asthma training program has been selected, exercise is not generally considered risky for asthma patients. Nevertheless, the results showed that by doing regular light exercises associated with activity tolerance increment, the process of transportation of oxygen to body tissues can be facilitated. Although the purpose of the researchers in this study was not evaluation of pulmonary indexes, activity tolerance increment facilitated the process of transportation of oxygen to body tissues which is an obvious limitation for asthmatics. As a result, an eight-week moderate aerobic exercise program lead to significant and favorable changes in cardiovascular parameters including heart rate, blood pressure, peak oxygen consumption, minute ventilation, and tolerance toward activities in overweight women with chronic asthma. Assuming the demonstrated results of the survey of influences of physical activities in patients with mild asthma, it is vital to consider the impact of physical activity monitors experimentally and the benefit of treadmill equipment for tolerance of activities regarding other domains of mild and severe asthma, and also by conducting different scopes and intensities of laboratory activities.

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Notes

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References

[1] Cypcar D, Lemanske Jr RF. Asthma and exercise. Clinics in chest medicine 1994; 15: 351-68.
[2] De Ste Croix MB, Deighan MA, Ratel S, Armstrong N. Age-and sex-associated differences in isokinetic knee muscle endurance between young children and adults. Applied Physiology, Nutrition, and Metabolism 2009; 34: 725-31.
[3] Razavi MZ, Nazarali P, Hanachi P, Kordi M. Effect of a Course of Aerobic Exercise and Consumption of Vitamin D Supplementation on Respiratory Indicators in Patients with Asthma.2013.
[4] Alioglu B, Ertugrul T, Unal M. Cardiopulmonary responses of asthmatic children to exercise: analysis of systolic and diastolic cardiac function. Pediatric pulmonology 2007; 42: 283-9.
[5] Masoli M, Fabian D, Holt S, Beasley R. The global burden of asthma: executive summary of the GINA Dissemination Committee report. Allergy 2004; 59: 469-78.
[6] Nystad W, Meyer HE, Nafstad P, Tverdal A, Engeland A. Body mass index in relation to adult asthma among 135,000 Norwegian men and women. American journal of epidemiology 2004; 160: 969-76.
[7] Gold DR, Damokosh AI, Dockery DW, Berkey CS. Body-mass index as a predictor of incident asthma in a prospective cohort of children. Pediatric pulmonology 2003; 36: 514-21.
[8] Camargo CA, Weiss ST, Zhang S, Willett WC, Speizer FE. Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. Archives of Internal Medicine 1999; 159: 2582-8.
[9] Shedeed SA. Right ventricular function in children with bronchial asthma: a tissue Doppler echocardiographic study. Pediatric cardiology 2010; 31: 1008-15.
[10] Gabe J, Bury M, Ramsay R. Living with asthma: the experiences of young people at home and at school. Social science & medicine 2002; 55: 1619-33.
[11] Ram FS, Robinson SM, Black PN. Effects of physical training in asthma: a systematic review. British Journal of Sports Medicine 2000; 34: 162-7.
[12] Nici L, Donner C, Wouters E, Zuwallack R, Ambrosino N, Bourbeau J, Carone M, Celli B, Engelen M, Fahy B. American thoracic society/European respiratory society statement on pulmonary rehabilitation. American journal of respiratory and critical care medicine 2006; 173: 1390-413.
[13] Noonan V, Dean E. Submaximal exercise testing: clinical application and interpretation. Physical therapy 2000; 80: 782-807.
[14] Santuz P, Baraldi E, Filippone M, Zacchello F. Exercise performance in children with asthma: is it different from that of healthy controls? European Respiratory Journal 1997; 10: 1254-60.

[15] Zhao X, Lin Y. (The practicability of increasing exercise tolerance in mild to moderate asthmatic patients). Zhonghuajie he hehu xi zazhi= Zhonghuajiehe he huxizazhi= Chinese journal of tuberculosis and respiratory diseases 2000; 23: 332-5.
[16] Enright Pl, the Six-Minute Walk Test. Respiratory Care 2003; 48: 783-785.
[17] Nazem F, Izadi M, Jaliliu M, Keshvarz B. Impact of aerobic exercise and detraining on pulmonary function indexes in obese middle-aged patients with chronic asthma. Arak Medical University Journal 2013; 15: 85-93.
[18] Forno E, Acosta-Pérez E, Brehm JM, Han Y-Y, Alvarez M, Colón-Semidey A, Canino G, Celedón JC. Obesity and adiposity indicators, asthma, and atopy in Puerto Rican children. Journal of Allergy and Clinical Immunology 2014; 133: 1308-14. e5.
[19] Pouyan Majd S DRV, and Fathi R. Effect of Exercise on Cardiorespiratory function in obese Children with Astma in Different Moisture Leveles. Medical Sciences Journal (YUMSJ) 2014: 529-41.
[20] Mohammad I, Valiollah S, Vahid I, editors. Maximal oxygen consumption in asthma patients before and after aerobic training program. Biological Forum; 2014: Research Trend.
[21] vanVeldhoven NH, Vermeer A, Bogaard J, Hessels MG, Wijnroks L, Colland V, van Essen-Zandvliet EE. Children with asthma and physical exercise: effects of an exercise programme. Clinical rehabilitation 2001; 15: 360-70.
[22] Freeman W, Nute M, Williams C. The effect of endurance running training on asthmatic adults. British journal of sports medicine 1989; 23: 115-22.
[23] Cooper CB. Exercise in chronic pulmonary disease: aerobic exercise prescription. Medicine and science in sports and exercise 2001; 33: S671-9.
[24] Roelofs R, Gurgel RQ, Wendte J, Polderman J, Barreto-Filho JAS, Solé D, Motta-Franco J, Munter JD, Agyemang C. Relationship between asthma and high blood pressure among adolescents in Aracaju, Brazil. Journal of Asthma 2010; 47: 639-43.
[25] Dogra S, Ardern CI, Baker J. The relationship between age of asthma onset and cardiovascular disease in Canadians. Journal of Asthma 2007; 44: 849-54.
[26] Fesharaki M, SMJ OP, Kordi R. The effects of aerobic and strength exercises on pulmonary function tests and quality of life in asthmatic patients. Tehran University of Medical Sciences 2010; 68.
[27] Casaburi R, Porszasz J, Burns MR, Carithers ER, Chang R, Cooper CB. Physiologic benefits of exercise training in rehabilitation of patients with severe chronic obstructive pulmonary disease. American journal of respiratory and critical care medicine 1997; 155: 1541-51.
[28] Cornelissen VA, Fagard RH. Effects of endurance training on blood pressure, blood pressure–regulating mechanisms, and cardiovascular risk factors. Hypertension 2005; 46: 667-75.
[29] Clark C. The role of physical training in asthma. CHEST Journal 1992; 101: 293S-8S.
[30] Azab NY, El Mahalawy II, El Aal GAA, Taha MH. Breathing pattern in asthmatic patients during exercise. Egyptian Journal of Chest Diseases and Tuberculosis 2015; 64: 521-7.
[31] STDRMS W. Can a regular exercise program improve your patient's asthma? Journal of Respiratory Diseases 2001; 22: 340.
[32] Moser KM, Bokinsky GE, Savage RT, Archibald CJ, Hansen PR. Results of a comprehensive rehabilitation program physiologic and functional effects on patients with chronic obstructive pulmonary disease. Archives of internal medicine 1980; 140: 1596-601.
[33] Hallstrand TS, Bates PW, Schoene RB. Aerobic conditioning in mild asthma decreases the hyperpnea of exercise and improves exercise and ventilatory capacity. CHEST Journal 2000; 118: 1460-9.
[34] Clark CJ, Cochrane LM. Assessment of work performance in asthma for determination of cardiorespiratory fitness and training capacity. Thorax 1988; 43: 745-9.
[35] Turner LA, Mickleborough TD, McConnell AK, Stager JM, Tecklenburg-Lund S, Lindley MR. Effect of inspiratory muscle training on exercise tolerance in asthmatic individuals.2011.
[36] Farid R, Azad FJ, Atri AE, Rahimi MB, Khaledan A, Talaei-Khoei M, Ghafari J, Ghasemi R. Effect of aerobic exercise training on pulmonary function and tolerance of activity in asthmatic patients. Iranian Journal of Allergy, Asthma and Immunology 2005; 4: 133-8.
[37] Eakin EG, Resnikoff PM, Prewitt LM, Ries AL, Kaplan RM. Validation of a new dyspnea measure: the UCSD Shortness of Breath Questionnaire. Chest Journal 1998; 113: 619-24.
[38] Cambach W, Chadwick-Straver R, Wagenaar R, Van Keimpema A, Kemper H. The effects of a community-based pulmonary rehabilitation programme on exercise tolerance and quality of life: a randomized controlled trial. European Respiratory Journal 1997; 10: 104-13.
[39] Casaburi R. Physiologic responses to training. Clinics in chest medicine 1994; 15: 215-27.
[40] Mirdar S, Arabzadeh E, Hamidian G,Effects of two and three weeks of tapering on lower respiratory tract in the maturing rat. koomesh 2015; 16: 366 – 375.
[41] M, Ghanbarzadeh M, Habibi Ah, Nikbakht M, Shakeriyan S, Baghernia R, AhadiF, Effects of exercise with lower and upper extremities on respiratory and exercise capacities of asthmatic patients. koomesh 2013; 15:89-101.