Research Article

Effect of Obesity on Exercise Capacity in Asthmatic Patients: A Cross-Sectional Study

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Abstract

Objectives: The obesity is a major risk factor for asthma, which is a serious and complex public health problem. The effect of obesity on exercise capacity in patients with asthma is unknown. Therefore, we aim to compare the exercise capacity between obese and non-obese patients who are diagnosed with asthma. **Materials & Method:** Forty-six male asthmatic patients participated in the study. The study used a cross-sectional design; Participants were categorized into two groups, for comparison between 23 obese asthmatics (group A) and 23 non-obese asthmatics (group B). Height, weight, and level of physical activity questionnaire were obtained. Also, maximal oxygen consumption (VO_2 max) value and cardiopulmonary responses were measured during incremental cycle exercise test. **Results:** VO_2 max and Metabolic Equivalents (METS) were significantly higher in non-obese asthmatic patients compared to obese asthmatic patients (23 ± 7.5 *vs.* 17.6 ± 3.8, p<0.05) for VO2 max, and (6.48 ± 2.1 *vs.* 5.09 ± 1.00, p<0.05) for METS. No significant differences were observed in cardiopulmonary responses (Heart rates and Oxygen saturation). **Conclusion:** Obesity might have unfavorable effects on exercise capacity (VO_2 max) in patients who are diagnosed with asthma. Obese asthmatics had reduced cardiopulmonary fitness compared with non-obese asthmatics, while the cardiopulmonary responses were similar in both groups.

Keywords: Obesity; Asthma; Maximal oxygen uptake

Introduction

Asthma classified as serious and complex public health problem, the number of affected people about 300 million in all ages around the world. [1] Asthma is one of the most common chronic diseases; it is usually starts in early childhood. [2] There are differences between health care centers managing asthma around the world based on the local context, access to resources, and the health system. Asthma causes symptoms such as shortness of breath, wheeze, chest tightness, and cough. Breathing difficulty is the main issue for asthma patients; it is due to airway narrowing, airway wall thickening, and increased mucus. Smoking, dust, viral infections (colds), changes in weather, and pollens are factors that may trigger or worsen asthma symptoms. [1]

In the Middle East region, the prevalence of asthma is lower than most developed countries, as a total asthma rate of 7.57 % was reported among 13 years-14 year old children, and 7.43% among 6 years-7 year old children. [3] Among adults in Middle East, the observed adjusted prevalence of asthma was about 4.4% to 7.6 %. [4] In Saudi Arabia, the prevalence of wheezing in 2017 was about 18.2%, and physician-diagnosed asthma reported was 11.3 %, based on survey using the European Community Respiratory Health Survey questionnaire conducted in Riyadh among adultaged 20 years-44 years. [5] Locally, Riyadh had the highest prevalence of asthma in Saudi Arabia. [6]

Obesity might worsen the symptoms of asthma in asthmatics. The prevalence of obesity has doubled in more than 70 countries since 1980, with more than 603 million obese adults depending on Body Mass Index (BMI) calculation where overweight is defined as BMI is between ≥ 25 and <30, and obesity is defined as BMI is 30. [7] Obesity is one of the primary causes leading to diabetes, hypertension, and cardiovascular diseases. [8] In Saudi Arabia, there is an increasing in prevalence of overweight and obesity. [9] 54.3% of adults in Saudi Arabia (18 years or older) were overweight and obese while 45.7 % of population were non-obese. [10] With increasing prevalence of obesity, the prevalence of asthma is expected to grow proportionally. [11] Obesity affects the respiratory system negatively because it restricts lungs expansion and reduces lungs volume. [12] The obesity is a major risk factor for asthma and it is associated with a more severe clinical course of disorder. [13] High body mass leads to difficulty in controlling asthma and develops the symptoms associated with asthma. [14] Several factors make some asthmatics avoid physical activity such as feeling that asthma may affect the ability to exercises. [15] Or having negative expectations and fear that physical activity might aggravate asthma's symptoms. [16]

Decreasing physical activity might affect cardio respiratory

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fitness level represented by maximal oxygen uptake (VO_2 max) in asthmatics negatively. VO_2 max was reduced in obese children with asthma when compared to non-obese children with asthma. [17] Cortés-Télles et al. [18] reported a lower VO_2 max in obese asthmatics when compared to normal-weight asthmatics. However, the sample size was low (14 participants in each group), and they did not include overweight asthmatics in the study.

Therefore, we aimed to study the effect of obesity on exercise capacity in obese- and non-obese-asthmatics. We hypothesized that obese-asthmatics would have reduced VO2 max when compared to non-obese-asthmatics. Knowing this information should help clinicians to implement an appropriate exercise program for obese-asthmatics if the hypothesis came true.

Methods

Participants

Forty-six men asthmatics participated, and they were recruited from Security Forces Hospital in Riyadh, Kingdom of Saudi Arabia from 20/12/2018 to 25/4/2019. Participants were screened by pulmonologists according to the following inclusion criteria; age (18 years-50 years), obeseasthmatic patients (BMI $\geq$ 30 kg/m^2) and non-obese asthmatic patients (BMI <30 kg/m^2), including overweight, underweight, and average body weight patients. [19] The exclusion criteria included; smokers, unstable asthmatic (based on Asthma Control Test, score >19) [20] cardiovascular patients and history of chronic illness or musculoskeletal disorders that might restrict their ability to perform the study's protocol. Asthmatics, who fulfilled the study criteria and agreed to participate in the study, signed the informed consent form, after ethical approval of the study proposal was given by Institutional Review Board at Imam Abdurrahman Bin Faisal University (IRB-PCS-2018-03-287).

Instrumentation

Arabic (short version) of International Physical Activity Questionnaire (IPAQ) was used to assess patient's physical activity level; it includes 7 main questionsfocus on physical activities (mild, moderate, or vigorous) of the last week, it is valid and reliable for that. [21] Cycle ergometer (E-N cardio, bike rahe, Netherlands), using Cosmed Fit Mate Metabolic System were applied as a cardiopulmonary exercise testing system to measure selected pulmonary parameters including VO_2 max and Metabolic Equivalents (METs). It is valid and reliable method to measure VO_2 max and METs. [22]

Study's protocol

The study was conducted within physical therapy department of Security Forces Hospital in Riyadh, Kingdom of Saudi Arabia, between 8:30 AM-11:30 AM, to minimize the effects of diurnal biological variations. [23] All study procedures were applied within a private room to insure patient's privacy. Patients were categorized into two groups; group "A" included 23 obese asthmatics and group "B" included 23 non-obese asthmatics. Participants were asked not to use the respiratory medications before 24 hours of exercise test and caffeine or heavy meals before 12 hours of testing. [18] All study procedures were applied within one session for every participant, including anthropometric data collection (body weight, height and BMI) andIPAQ. Before starting cardiopulmonary exercise test, the following resting measures were recorded; Heart Rate (HR) and Peripheral Oxygen Saturation (SpO_2). Then, cardiopulmonary exercise testing was applied as follow; VO_2 max mask and finger monitor device were connected to patient, a 3 min period of warm-up of unloaded pedaling, followed by stepwise increases in work rate by 20 watts every 2 min until symptom limitation (20 W-40 W-60 W-80 W-100 W). [24] All steps of study procedures were closely supervised by a physical therapist for instructions and ensuring safety issues. Vital signs were thoroughly monitored for any sudden abrupt changes.

Outcome Measures

VO_2 max was recorded as a primary outcome. Cardiopulmonary responses were recorded including; HR and SpO_2 at every stage of exercise testing.

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows (version 22.0). Descriptive analysis had been done for all variables, means and standard deviations were calculated. Unpaired t-test was utilized to detect the differences between the two groups for VO_2 max, HR, and SpO_2 during each work rate stage of exercise test. Unpaired t-test was utilized to detect the differences between groups of dyspnea perception and leg fatigue levels before and after the exercise test. The significance level was set at $\rho<0.05$, and the results are reported as means ± Standard Deviation (SD) unless otherwise specified.

Results

Study population characteristics

Of the 79 asthmatics recruited to participate in this study, data for 46 participants were included in analysis. [23] Obese asthmatics (group A) and 23 non-obese asthmatics (group B).

The total excluded patients were thirty-three, 25 of them did not meet the study criteria, and 8 patients declined to participate in the study.

Subjects' characteristics are presented in [Table 1]. There was a statistically significant difference in the mean ages of obese-asthmatics compared with non-obese-asthmatics (40 ± 9.1 *vs.* 33 ± 9.6 y, p=0.020) respectively. The obese-asthmatics included 16 participants class I obesity according to BMI (BMI 30.0 kg/m^2-34.9 kg/m^2) and seven patients class II (BMI 35.0 kg/m^2-39.9 kg/m^2). [18] The non-obese asthmatic included 16 participants as overweight (BMI 25.0 kg/m^2-29.9 kg/m^2), six patients normal weight (BMI 18.5 kg/m^2-24.9 kg/m^2), and one patient underweight (BMI <18.5 kg/m^2). According to IPAQ, participants of both groups were physically inactive in general, but obese-asthmatics reported a slightly higher physical activity score compared with non-obese-asthmatics.

Cardiopulmonary responses

HR and SpO2 data are reported numerically in [Table 2], and showed in [Figures 1 and 2]. No statistically significant

Table 1: Anthropometric and clinical characteristics of participants.

	Group Obese (A) n= (23) Non-obese (B) n= (23)	Mean ± Standard Deviation (SD)	Mean difference	P value	T-test	95 % Confidence interval of the difference	
						Lower	Upper
Age-years	A	40.04 ± (9.18)*	6.739	0.02	2.421	1.128	12.35
	B	33.30 ± (9.69)				1.128	12.35
Height-cm	A	169.30 ± (4.08)	-1.521-	0.303	-1.042	-4.466	1.422
	B	170.82 ± (5.69)				-4.474	1.431
weight-kg	A	95.95 ± (6.77)*	21.086	<0.001	7.318	15.279	26.894
	B	74.86 ± (12.04)				15.235	26.938
BMI-kg/m^2	A	33.49 ± (2.39)*	7.952	<0.001	9.367	6.241	9.663
	B	25.54 ± (3.28)				6.236	9.667
IPAQ-MET/min per week	A	517.04 ± (643.61)	6.261	0.732	0.345	-292.238	412.76
	B	456.78 ± (537.93)				-292.552	413.074
Asthma-years	A	16.83 ± (9.22)	2.478	0.389	0.87	-3.263	8.22
	B	14.35 ± (10.08)				-3.264	8.221

Abbreviations: BMI: Body Mass Index (kg/m^2); IPAQ: International Physical Activity Questionnaire; kg: kilogram; cm: centimeter; m: meter; MET: Metabolic Equivalent. *: Significantly difference from non-obese asthmatics, p< 0.05.

Table 2: Cardiopulmonary responses to exercise test.

	Group		Mean ± Standard Deviation (SD)	Mean difference	P value	T	95 % Confidence interval of the difference	
							Lower	Upper
HR-bpm at rest	A	*n*= (23)	84.17 ± (10.60)	1	0.746	0.326	-5.180	7.18
	B	*n*= (23)	83.17 ± (10.19)				-5.181	7.181
HR-bpm Stage 1	A	*n*= (23)	105.87 ± (12.29)	-3.304	0.455	-0.753	-12.147	5.539
	B	*n*= (23)	109.17 ± (17.07)				-12.173	5.564
HR-bpm Stage 2	A	*n*= (23)	119.65 ± (11.67)	-3.957	0.387	-0.873	-13.088	5.174
	B	*n*= (23)	123.61 ± (18.32)				-13.134	5.221
HR-bpm Stage 3	A	*n*= (19)	133.32 ± (13.70)	-5.384	0.368	-0.912	-17.352	6.584
	B	*n*= (20)	138.70 ± (22.00)				-17.276	6.508
HR-bpm Stage 4	A	*n*= (11)	146.55 ± (16.03)	-2.727	0.764	-0.305	-21.390	15.935
	B	*n*= (11)	149.27 ± (24.96)				-21.599	16.145
HR-bpm Stage 5	A	*n*= (1)	160 ± (.)	15	0.66	0.487	-83.004	113.004
	B	*n* = (4)	145 ± (27.54)					
SpO_2-% at rest	A	*n*= (23)	98.70 ± (0.765)	-0.304	0.177	-1.373	-0.751	0.142
	B	*n*= (23)	99 ± (0.739)				-0.751	0.142
SpO_2-% Stage 1	A	*n*= (23)	98.39 ± (0.941)	0.043	0.882	0.15	-0.542	0.629
	B	*n*= (23)	98.35 ± (1.027)				-0.542	0.629
SpO_2-% Stage 2	A	*n*= (23)	97.61 ± (1.076)	-0.174	0.602	-0.526	-0.841	0.493
	B	*n*= (23)	97.78 ± (1.166)				-0.841	0.493
SpO_2-% Stage 3	A	*n*= (19)	97.74 ± (0.872)	0.237	0.515	0.658	-0.492	0.966
	B	*n*= (20)	97.50 ± (1.131)				-0.488	0.961
SpO_2-% Stage 4	A	*n*= (11)	97.36 ± (0.809)	-0.182	0.719	-0.365	-1.220	0.857
	B	*n*= (11)	97.55 ± (1.440)				-1.239	0.875
SpO_2-% Stage 5	A	*n*= (1)	96 ± (.)	-1.5	0.103	-2.324	-3.544	0.554
	B	*n*= (4)	97.50 ± (0.577)				.	.

Abbreviations: HR: Heart Rate; bpm: beat per minute; SpO_2: Arterial Oxygen Saturation (percentage).

differences were observed in HR and SpO2 whether at rest or during the five different stages of exercise test between group A and B. The HR was higher and the SpO2 was lower at the stage 5 in the obese-asthmatics when compared to non-obese-asthmatics, although the differences were not statistically significant.

Exercise test performance

The exercise test performance was reported in [Table 3]. The differences in ventilation per minute (VE) and Fractional Content of Expired Oxygen (FeO_2) at the end of exercise were statistically insignificant between groups. The VO_2 max (volume per time) and METs were significantly higher in non-obese-asthmatics compared to obese-asthmatics (23 ± 7.5 *vs.* 17.6 ± 3.8, p<0.05) for VO_2 max, and (6.48 ± 2.1 *vs.* 5.09 ± 1.00, p<0.05) for METS, respectively.

Discussion

The aim of this study was to investigate the impact of obesity on exercise capacity in obese and non-obese asthmatics. Also, we aimed to compare cardiopulmonary responses in relation to exercise capacity between obese and non-obese asthmatics. We

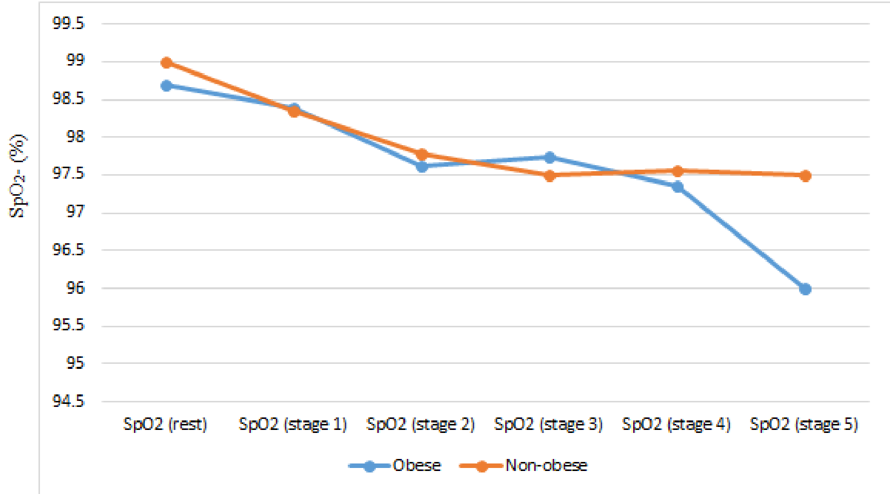

Figure 1: The changes of Oxygen Saturation (SpO_2) in group A and group B during the exercise test.

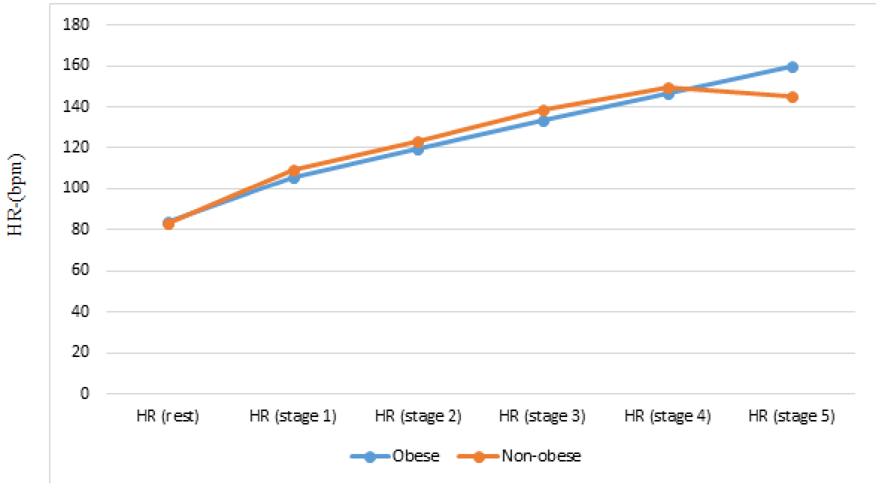

Figure 2: The changes of heart rates in group A and group B during the exercise test. HR: Heart Rate; bpm: beat per minute.

Table 3: Exercise test performance.

	Group Obese (A) n= (23) Non-obese (B) n= (23)	Mean ± Standard Deviation (SD)	Mean difference	P value	T	95 % Confidence interval of the difference	
						Lower	Upper
VE- L/min	A	47.63 ± (14.902)	-4.995	0.278	-1.089	-14.166	4.175
	B	52.63 ± (15.941)				14.167	4.176
FeO_2-%	A	16.66 ± (0.533)	-0.287	0.117	-1.598	-0.648	0.074
	B	16.95 ± (0.766)				-0.649	0.075
$VO_{2\,max}$-ml/kg/min	A	17.62 ± (3.855)*	-5.430	0.004	-3.070	-8.995	-1.865
	B	23.05 ± (7.556)				-9.030	-1.830
METs	A	5.09 ± (1.083)*	-1.391	0.009	-2.749	-2.411	-0.371
	B	6.48 ± (2.172)				-2.422	-0.361

Abbreviations: VE: minute Ventilation; L: Liter; min: minute; FeO_2: Fractional content of expired oxygen (percentage); VO_{2max}: Maximal oxygen uptake; ml: milliliter; kg: kilogram; METs: Metabolic Equivalents. *: Significantly different from non-obese asthmatics, p<0.05.

found that the VO_2 max and METS were significantly higher in non-obese asthmatics compared to obese asthmatics. In addition, there was no statistically significant difference between obese and non-obese asthmatics in the cardiopulmonary responses (HR and SpO_2) throughout the stages of exercise test. [24]

Cardiopulmonary responses

All participants of the study groups (A and B) had reached the stage II of cardiopulmonary exercise testing. Almost 85% participants of each group reached stage III of the exercise test. The fatigue ability could let only 45% in both groups to continue to stage IV of the cardiopulmonary exercise testing. Less than 20% of group B could persist with stage V, and only one patient from group A reached stage V level of cardiopulmonary exercise testing [Table 2]. All the participants in both groups did not reach the maximal heart rates values based on the formula (maximum heart rate=207–(0.7 × age)). [25] The reasons behind not completing the cardiopulmonary exercise testing might be due to leg fatigue or dyspnea before reached to the maximal predicted heart rates, and all participants could not pass the stage V of the cardiopulmonary exercise testing [Table 2]. There was a slightly lower HR mean values for participants of group A, compared with participants of group B in stage V [Figure 2], but these differences were not statistically significant Rastogiet al. [26] found that HR before six-minute walk test (6 MWT) was significantly higher among obese asthmatics as compared to normal weight asthmatics. In addition, HR after 6 MWT was significantly higher among obese asthmatics as compared to normal weight asthmatics. However, Rastogiet al. [26] recruited adolescents and used 6MWT to measure the exercise capacity; thus, the comparison with the current study is not suitable. In the current study, SpO_2 results were identical in obese and non-obese asthmatics, and these results are similar to the results reported previously. [18] Cortés-Télles et al. [18] found no difference in SpO_2 between obese and non-obese asthmatics. Cortés-Télles et al. [18] found that there was no statistically significant difference between asthmatics patients compared with non-asthmatics subjects, as both groups achieved similar maximal HR and SpO_2. The results of the current study are similar to the two studies [18,24] although the obese asthmatics in the current study had higher ages when compared to non-obese asthmatics and the groups in those two studies. [18,24] It seems that both HR and SpO_2 values were not affected by obesity or asthma during the exercise tolerance test. Being sedentary might be the factor that has the main effect on HR and SpO_2 but not the obesity or asthma. However, we could not draw a solid conclusion regarding being sedentary and the responses of HR and SpO_2 because it was beyond the scope of the current study.

Exercise test performance

The minimum result of VO_2 max was 8.8 ml/kg/min) for the obese asthmatics *vs.* (7.4 ml/kg/min) for the non-obese asthmatics; (showed non-significant difference). The significant difference was in the maximum result of VO_2 max (24.5 ml/kg/min) for obese asthmatics *vs.* (37.1 ml/kg/min) for non-obese asthmatics. Cortés-Télles et al. [18] speculated that the VO_2 max measure is the best standard for assessing cardiopulmonary fitness relative to BMI (kg/m^2). The obese asthmatics were significantly lower than normal weight asthmatics in exercise capacity during 6MWT. [26] In addition; the results reported by Lorenzo et al. [27] related to VO_2 max and VE values were similar to the results of the current study even though their subjects were healthy non-obese and obese. This might outweigh the effects of obesity on exercise capacity regardless of having asthma. However, we could not confirm this speculation because we did not include healthy participants in the current study. The previous studies interested in cardiopulmonary fitness for asthmatics were rare and have shown conflicting results. Clark and Cochrane [28] found that indices of VO_2 max were reduced in asthmatics compared with healthy participants. Researchers predicted that physical inactivity life in asthmatics is the cause of reduced exercise capacity rather than underlying airflow obstruction. In contrast, the result of study by Chryssanthopoulos et al. [29] found that reduced VO_2 max might be due to narrowing airway. Garfinkel et al. [15] found that asthmatics (mild to moderate) had normal values of VO_2 max. Cortés-Télles et al. [24] added that there was no statistically significant difference in VO_2 max values between asthmatics compared with non-asthmatics. Türk et al. [30] found that the obese asthmatics had a lower relative maximal exercise capacity compared with the non-obese asthmatics but not reach to statistically significant differences. The effect of increasing BMI on VO_2 max was evident in obese asthmatics compared to normal weight asthmatics. [18] Our results showed that the VO_2 max was significantly higher in non-obese asthmatics compared to obese asthmatics, which in concordant with. [31] Although the study was conducted on healthy adolescents. Thus, decreased BMI might be the reason for higher exercise capacity in non-obese asthmatics versus obese asthmatics. Taking all information together, it appears that the asthma itself had no effect on VO_2 max while the effect of obesity on VO_2 max was evident in obese asthmatics in the current study and in the previous two studies. [18,24] The samples size in those studies were low, and we could not confirm their results since we did not recruit healthy people. Also, the design of the current study is limited to conclude the effect of obesity alone on VO_2 max. Thus, further investigations are needed in the future.

Limitations

Our study has several limitations. First, we recruited men only due to hospital regulations, and we recruited all participants from one hospital. Thus, the results should be interpreted with caution and should not be generalized for women. The design of the current study was a cross-sectional which is limited in determining the cause and effect relationship between the variables; however, the primary aim of the current study was to assess the differences of exercise capacity and responses of HR and SpO_2 between obese and non-obese asthmatics. VO_2 max is affected by the percentage of fat in the body, and BMI is not specific for measuring the fat alone [31]. Thus, measuring fat in the body might provide an accurate data regarding VO_2 max. Although we controlled for taking medications time, we did not control for the type of medications for asthma or other chronic disease which might have effects on the results. Large multicenter randomized control studies should be conducted to replicate our study on men and women with better control on some covariates such as medications for asthma.

Conclusion

The effect of obesity was evident on exercise capacity (VO_2 max) in obese asthmatics. Obese asthmatics had significantly reduced cardiopulmonary fitness compared with non-obese asthmatics. The cardiopulmonary responses (HR and SpO_2) were identical in both groups. The findings of the current study can provide important information for clinicians to implement appropriate interventions for obese asthmatics to improve their exercise capacity. In addition, future studies should focus on the effect of weight loss on exercise capacity in obese asthmatics.

Conflict of interest

No conflicts of interest, financial or otherwise, are declared by the authors.

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