New Zealand Journal of

SPORTS MEDICINE

Official Journal of Sports Medicine New Zealand Inc

Volume 30 • Number 3 • Spring 2002

Does Interval Hypoxic Training affect the lung function of asthmatic athletes

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Abstract

Aim

To measure the effects of Interval Hypoxic Training, (IHT) on Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1) and Peak Expiratory Flow (PEF) of asthmatic and non-asthmatic subjects.

Study Design

Experimental research design comparing the response of asthmatic to non-asthmatic subjects.

Participants

Forty adult volunteers (20 asthmatics, age 32.2 $\pm$ 8.76 and 20 non-asthmatics, age 24.3 $\pm$ 8.55) took part in the study. All participants were involved in sport or regular physical activity.

Interventions

Each participant completed 15 sessions of IHT on different days over a 3 week period.

Outcome Measures

Lung function variables (FEV_1, FVC and PEF) were measured before and after each session. Lung function tests were repeated 1 month after completion of the IHT sessions. Asthmatics completed a questionnaire on symptoms and medication usage before and after IHT as well as at the 1 month follow-up.

Results

This study demonstrated a statistically significant increase, (p=.012) in FVC after IHT in both asthmatic and non-asthmatic participants. IHT did not demonstrate a significant bronchodilator effect, with no change in FEV_1 or Peak Expiratory Flow. However some asthmatics showed an improvement in symptoms and a reduction in medication use.

Conclusion

The findings from this study overall do not highlight any detrimental effect of IHT on the lung function variables measured.

Key Words:
Interval Hypoxic Training, Asthma, Lung Function, Altitude, Hypoxia.

Introduction

Physical performance and health improvements brought about by altitude exposure have been regularly debated[4, 5, 8, 11, 12]. The recent introduction into New Zealand of altitude simulators means that the effects of altitude may be obtained without having to relocate. The side effects of prolonged exposure such as nausea, dizziness and exhaustion commonly experienced while living at high altitudes may therefore be minimised[5].

The altitude simulators were first developed in Russia over 30 years ago[14]. These simulators delivered low levels of oxygen simulating an altitude environment at sea level. This lead to the development of the Interval Hypoxic Training (IHT) technique, which involved intermittent hypoxic exposure using an altitude simulator. This technique has been used to train Olympic and elite athletes as well as for improving general health and fitness. Russian researchers claim the benefits of IHT include increases in work capacity and performance.

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Improvements in recovery and the functioning of many body systems under extreme conditions are also published[6, 7].

Studies using treatment with intermittent hypoxia in participants with chronic bronchitis and asthma have found marked improvements in lung function with a reduction in medication use[7]. It has been suggested that intermittent hypoxic exposure may cause bronchodilation as opposed to bronchoconstriction as observed with chronic hypoxia[1]. However most studies in this field have been carried out in Russia and there is very little published in the western world on the effects of IHT on lung function. If it could be confirmed that IHT is beneficial to lung function and not detrimental to asthma status, then simulated altitude training may be a worthwhile addition to training programmes for both asthmatic and non-asthmatic athletes.

The aim of this study was to determine the effects of Interval Hypoxic Training on Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second, (FEV_1), and Peak Expiratory Flow, (PEF), of asthmatic and non-asthmatic participants.

Method

Participants

Forty adult volunteers participated in this study. All participants were involved in sport or regular physical activity. Asthmatic participants (n=20, age 32.2 ± 8.76) were defined as those on regular preventative medication for asthma. Asthma status was categorised as mild, moderate or severe[13]. Asthmatics were excluded if they had a hospital admission or a course of oral steroids in the previous three months. Non-asthmatic participants (n=20 age 24.3 ± 8.55) were excluded if they had a previous history of respiratory disease, smoking or lung function tests outside the normal range for age, weight and gender. Informed consent was gained from all participants and the study was approved by the Auckland University of Technology Ethics Committee.

Protocol

All participants completed a lung function assessment and medical questionnaire prior to the interval hypoxic training. Each participant then underwent 15 sessions of interval hypoxic training (IHT) over a 3-week period. IHT was applied by the participant breathing through a handheld mask while seated throughout the session. Each session consisted of the participants receiving repeated cycles of five minutes hypoxic exposure followed by five minutes normoxic (room air) exposure, for a total session time of 60 minutes.

The altitude simulator extracts oxygen from the air to achieve oxygen levels up to the equivalent of 22,500 feet altitude. A protocol is followed to establish a stepped adaptation. The blood oxygen content is continuously monitored with an pulse oximeter (Nonin Onyx) to ensure the desired level of blood oxygen desaturation is achieved. Throughout the 15 sessions, as the body progressively adapts to the hypoxic exposure, the oxygen content in the inspired air is gradually reduced to 9% to ensure the optimal hypoxic stimulus is maintained.

Lung function variables FVC, FEV_1 and PEF were measured using a hand held spirometer (Microlab 3500) before and immediately after each session. Asthmatic participants also completed a follow-up questionnaire assessing asthma status and medication history at the completion of the 15 days of IHT.

Follow up Testing

Nineteen participants (11 asthmatics) completed follow up lung function assessment one month after the completion of the IHT sessions. Asthmatics also completed another questionnaire on asthma status and medication usage.

Data Analysis

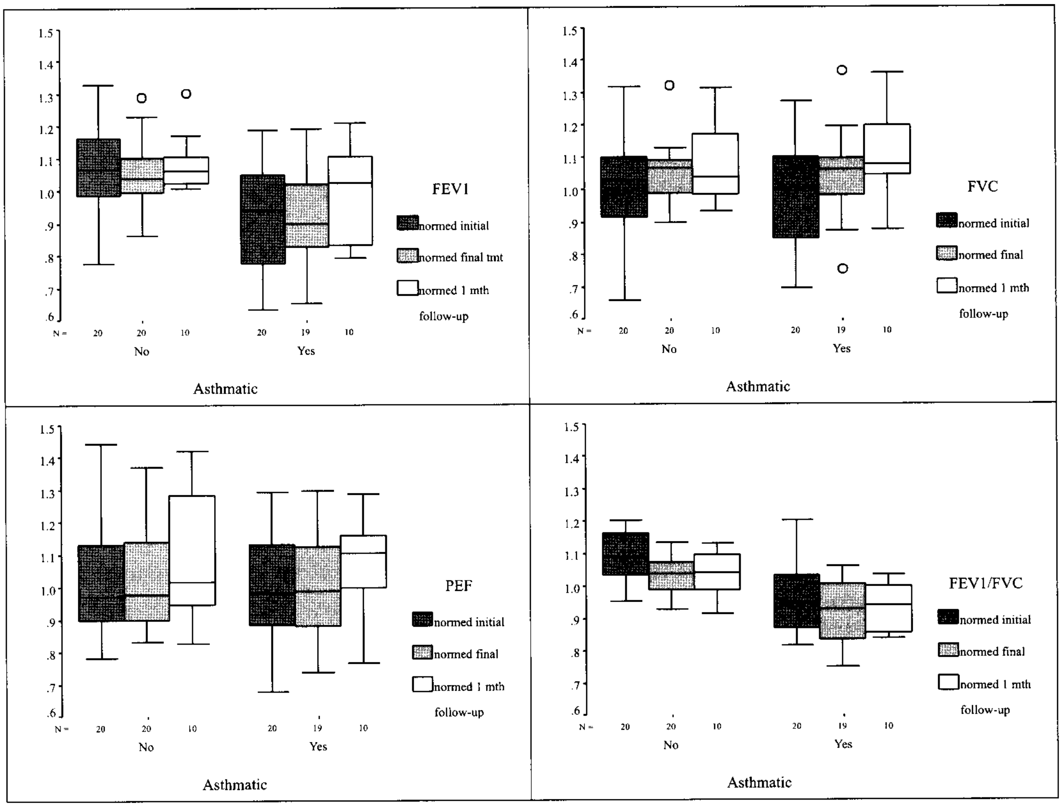
All data were standardised for age and height by dividing by the predicted normal values (ECCS)[2] for each subject. For each lung function variable, the pre IHT treatment responses were compared for the first and final day of the treatment period using repeated measures analysis of variance (ANOVA). Thirty nine participants completed these two measurements. However, only 19 participants completed the one month follow-up session. Therefore, separate repeated measures ANOVAs were used to compare the three pre IHT responses. Post hoc pairwise comparisons, using a Bonferroni correction, were used to compare the responses at the different times. All analyses were conducted using SPSS 10.0 for Windows (SPSS Inc 1999).

Results

The responses of the standardised lung function variables over the IHT treatment period are shown in Figure 1. FVC increased significantly (p=0.012) after the three weeks of IHT treatment in both asthmatic and non-asthmatic participants. FVC remained significantly higher than the initial FVC average for a further one month period, (p=0.006).

The results also showed asthmatics had a significantly lower FEV_1 (p=0.008) and FEV_1/FVC% (p<0.001) when compared with the non-asthmatic group over the IHT treatment period. These differences are consistent with the characteristics of

Figure 1. The response to IHT for standardised lung function variables for asthmatic and non -asthmatic participants.



asthma. However the overall effects of IHT on FVC, FEV_1 and PEF did not differ between the asthmatic and non-asthmatic groups.

No significant difference was demonstrated in response to IHT in either group for FEV_1 or Peak Expiratory Flow. However as FVC increased in both groups, an overall decrease in FEV_1/VC % was found after the IHT treatment period ($p<0.001$). As would be expected FEV_1/FVC % remained higher in the non asthmatic group throughout the treatment and follow up period.

When comparing FEV_1 and PEF before and after each session, on each of the 15 days, no significant differences were found. Therefore there was no evidence to suggest an acute bronchoconstrictor response to IHT.

Medication

At the completion of the 15 days of IHT, no asthmatics reported a deterioration in their asthma status either during the 15 day treatment or in the follow up period. Eight asthmatics (5 moderate and 3 mild) commented that their asthma had improved from the pre IHT treatment level and reported a reduction in their medication usage. In 7 of these asthmatics the use of the "reliever" was reduced from regular to occasional or not at all. The use of the "preventer" stayed fairly consistent for all asthmatics.

Six asthmatics commented that their asthma had remained improved at the one month follow up. Four asthmatics indicated that there had been "no change", however three of these decreased their medication from the pre treatment phase reducing their use of the "reliever" to infrequently. The pattern of medication usage has remained fairly consistent from the end of the 15 day treatment through to the one month follow up period.

Discussion

Fifteen days of IHT has demonstrated a statistically significant increase in FVC which was maintained for a one month period.

However this represents an increase in volume of 6%. Clinically and in relation to athletic performance the relevance of this is low. These results however are consistent with other research which also claims an increase in VC with IHT treatment[9]. This previous research did not specify the magnitude of this increase so direct comparisons cannot be made. The results of this study indicate no significant increase in FEV_1 or Peak flow over the 15 day IHT treatment period for either asthmatics or non-

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asthmatics. This is in contrast to previous research[1] which suggested that IHT may cause a bronchodilator effect.

This study demonstrates that the IHT protocol used did not provoke a bronchoconstrictor response which can occur with chronic exposure to low levels of oxygen[1]. These results broadly agree with Geppe, Kurchatova et al,[3] who demonstrated in children that there was no detrimental effect of IHT on airway function. This is encouraging for the asthmatic athlete who may wish to supplement their training programme with IHT but are concerned as to the effect of hypoxia on airway function.

Athletes who are susceptible to developing exercise induced asthma or bronchospasm may be affected by the cooler, drier weather which prevails at altitude. For these athletes altitude training may prove difficult and in some instances not beneficial[5]. Therefore IHT may be a worthwhile consideration in these circumstances.

The reduction in medication usage by half of the asthmatics who had attended follow up is consistent with findings of other research. Redzhebova (1992) found, in a study of asthmatics, after 20-25 sessions of IHT that 33.8% of the participants decreased dosages of medication, 60% commented that attacks became less frequent and symptoms improved. Comments by asthmatics in this study included less shortness of breath, not having such a tight chest, not as wheezy . Other studies have also commented on attacks becoming less frequent and mild, periods of remission becoming longer, drug treatment reduced and children showing an improvement in mood. [3] This area may be worthy of further investigation to quantify the possible benefits of IHT to reducing medication for asthmatics.

Conclusion

This study demonstrates a statistically significant increase in FVC with IHT in both asthmatic and non-asthmatic participants. IHT was not associated with a significant bronchodilator effect, with no change in FEV_1 or PEF. However some asthmatic participants have shown an improvement in symptoms and a reduction in medication use. This is an area for further research. The findings from this study overall do not highlight any detrimental effect of IHT on the lung function variables measured.

Acknowledgements

The authors thank the participants of the study and the staff of Sport O_2, Takapuna, for the use of their equipment and facilities.

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