Abstract of Doctoral Thesis

Title: Effect of exercise under hypoxic condition on promotion of health

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Introduction

An increasing body of evidence suggests the health promotion benefits of exercise under hypoxic condition. Although previous studies indicated that exposure to severe hypoxia during rest or exercise led to improvements of glucose metabolism and appetite regulation, effect of moderate hypoxia on health promotion has not been fully understood.

Purpose

The purpose of the present study was to investigate the effect of exposure to moderate hypoxia on acute endocrine and appetite responses during rest and exercise, and metabolic syndrome-related risk markers following exercise training.

Methods

[Study 1]

The purpose of this study was to examine the effects of exposure to moderate hypoxia on endocrine and metabolic responses and substrate oxidation pattern. Eight healthy men completed two experimental trials: a rest trial under normoxic condition (FiO₂ = 20.9 %), and a rest trial under hypoxic conditions (FiO₂ = 15.0 %). Experimental trials were performed over 7 h in an environmental chamber. Blood and respiratory gas samples were collected to determine time courses of changes in metabolic, endocrine regulations, substrate oxidation patterns, and subjective feeling of appetite. In conclusion, endocrine and metabolic responses and substrate oxidation patterns were not affected by exposure to moderate hypoxia over 7 h.

[Study 2]

The purpose of this study was to examine the effects of exercise under moderate hypoxia on endocrine and metabolic responses and substrate oxidation patterns. Eight obese men completed four experimental trials: a rest trial under normoxic condition (FiO₂ = 20.9 %), an exercise trial under normoxic condition (FiO₂ = 20.9 %), a rest trial under hypoxic condition (FiO₂ = 15.0 %), and an exercise trial under hypoxic condition (FiO₂ = 15.0 %). Experimental trials were performed over 7.5
h in an environmental chamber. Blood and respiratory gas samples were collected over 7.5 h. In conclusion, endocrine response and appetite regulation during rest or exercise were not affected by exposure to moderate hypoxia over 7.5 h. However, exercise under hypoxic condition promoted carbohydrate oxidation compared with exercise under normoxic condition during exercise and post-exercise period.

[Study 3-1]

The purpose of this study was to examine the effects of training under hypoxic condition on metabolic risk markers. Twenty obese men underwent exercise training under normoxic condition \((\text{FiO}_2 = 20.9\%)\) or hypoxic condition \((\text{FiO}_2 = 15\%)\) for 4 weeks (3 days/week, 12 sessions in total). Each training session consisted of 55% of maximal oxygen uptake \((\text{VO}_2\text{max})\) evaluated under each oxygen condition. Before and after the training period, \text{VO}_2\text{max}, whole body fat mass, abdominal fat area, intramyocellular lipid content (IMCL), brachial-ankle pulse wave velocity \((\text{baPWV})\), and glycemic and appetite-related hormonal responses to meal consumption were determined. In conclusion, the postprandial blood glucose responses significantly decreased in both groups. Furthermore, the improvement of lowering postprandial glucose responses was significantly greater in the training group in hypoxia than in the training group in normoxia.

[Study 3-2]

The purpose of this study was to examine the influences of different periods of exercise training under hypoxic condition on metabolic risk markers. Twenty-one obese men underwent exercise training under moderate hypoxia \((\text{FiO}_2 = 15.0\%)\) for either 2 weeks (2wk group) or 4 weeks (4wk group). The subjects in the 2wk group completed training sessions 6 days/week for 2 weeks, whereas the subjects in the 4wk group participated in training sessions on 3 days/week for 4 weeks. Before and after the training period, \text{VO}_2\text{max}, whole body fat mass, abdominal fat area, \text{baPWV}, and fasting and postprandial glycemic responses were determined. Blood glucose responses to a 75 g glucose load did not change significantly in either group. However, serum insulin responses after a 75 g glucose load significantly decreased in the 4wk group, but not in the 2wk group. These results indicated that 4 weeks of exercise training under moderate hypoxia elicited a greater improvement in insulin sensitivity compared with an equivalent training program over 2 weeks.

Conclusion

These findings reveal that exercise under moderate hypoxia acutely promotes carbohydrate oxidation compared with exercise under normoxia. In addition, the present results indicate that exercise training under moderate hypoxia leads to greater improvement of glucose metabolism in obese people. Therefore, the present findings newly suggest potential benefit of exercise training under moderate hypoxia for promotion of health, particularly for improvement of glucose metabolism.