

Cardiorespiratory functions

Exposure to Normobaric Hypoxia with Exercise Training Improved Glycaemic Control and Cardiorespiratory Fitness in Patients with Type 1 Diabetes Mellitus

*A. Żebrowska¹, B. Głuchowska¹

¹Academy of Physical Education, Department of Physiological and Medical Sciences (Katowice, Poland)

Physiological responses to lowered inspired oxygen pressure either mediated by barometric pressure reduction or by lowering the oxygen fraction in diabetes mellitus are controversial. We aimed to evaluate the effect of normobaric hypoxia and exercise training on glycaemic control and cardiorespiratory fitness in patients with type 1 diabetes mellitus.

Methods: Twelve patients (age: 29.2±9.5 years) suffering from Type 1 diabetes (T1D) for 12.1±6.0 years and twelve randomly chosen healthy adults participated in the following trials: normoxic (NoRest: FIO₂=20.9%; P =990hPa) and hypoxic rest (HyRest: FIO₂=15.2% P=990hPa) and normoxic (NoEx) and hypoxic (HyEx) exercise training. Exercise tests were performed on a cycle ergometer Sports Excalibur (Lode, The Netherlands) in The Altitude Trainer Hypoxic System (LOWOXYGEN System, Poland). Cardiorespiratory variables, haematological indices, glycaemia, and glycated hemoglobin (HbA1c) were measured before exercise (pre-Ex), after the exercise training (post-Ex), and up to 24 hours after exercise training (post-ExR).

Results: Significantly lower SatO₂ was observed after exposure to HyRest compared to NoRest (91.0 vs 96.0 %, respectively; $P < 0.05$), and in response to both exercise protocols ($P < 0.001$). Exposure to HyEx significantly alter maximal pulmonary ventilation ($P < 0.01$) but not maximal oxygen uptake VO_{2max}. Hypoxia (HyRest) did not induce significant changes in blood glucose in T1D with a significant impact of HyEx ($P < 0.01$). Significantly lower BG levels were observed at maximal exercise intensity ($P < 0.01$) and in response to 15 minutes recovery period after Hy Ex ($P < 0.05$) compared to NoEx. A tendency to decreased (HbA1c) levels was observed in T1D after the two months of exercise training compared to pre-Ex values. **Conclusions:** Hypoxia with physical activity may have the most beneficial effect on short and moderate-term glycaemia control in patients with type 1 diabetes.

Schobersberger W, Schmid P, Lechleitner M, et al. Austrian Moderate Altitude Study 2000 (AMAS). The effects of moderate altitude (1,700 m) on cardiovascular and metabolic variables in patients with metabolic syndrome. *Eur J Appl Physiol* 2003; 88: 506-514.

Mackenzie R, Maxwell N, Castle P, et al. Intermittent exercise with and without hypoxia improves insulin sensitivity in individuals with type 2 diabetes. *J Clin Endocrinol Metab.* 2012; 97(4): 546-555.

Chen CH, Liu YF, Lee SD, et al. Altitude hypoxia increases glucose uptake in human heart. *High Alt Med Biol* 2009; 10: 83-86.

Castillo O, Woolcott OO, Gonzales E, et al. Residents at high altitude show a lower glucose profile than sea-level residents throughout 12-hour blood continuous monitoring. *High Alt Med Biol* 2007; 8: 307-311.

Wee J, Climstein M. Hypoxic training: Clinical benefits on cardiometabolic risk factors, *J Sci Med Sport* 2015; 18(1): 56-61.