Science & Sports (2014) 29, 306—310

Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

ORIGINAL ARTICLE

Salivary pH increases after jump exercises in hypoxia

Exercice de haute intensité et variations du pH salivaire en hypoxie

S. Julià-Sánchez[a], J. Álvarez-Herms[a], H. Gatterer[b], M. Burtscher[b], T. Pagès[a], G. Viscor[a,*]

[a] *Departament de Fisiologia i Immunologia, Universitat de Barcelona (UB), Avda. Diagonal 643, Edifici Ramon Margalef 3A, E-08028, Barcelona, Spain*
[b] *Department of Sport Science, University of Innsbruck, Innsbruck, Austria*

Received 15 July 2013; accepted 31 December 2013
Available online 23 June 2014

KEYWORDS
Salivary pH;
Exercise;
Hypoxia;
Anaerobic metabolism

Summary
Objectives. — The purpose of the present study was to determine if high intensity exercise performed in hypoxia could affect the salivary pH response in comparison to normoxia.
Methods. — Eight healthy and physically active subjects performed a randomized single blinded protocol consisting in six sets of 15 seconds stretch-shortening-cycles (SSC) jumping at three different conditions: (T1) baseline test at 550 m altitude, (T2) at 2500 m simulated altitude (O_2 = 16.4%), and (T3) at 4000 m simulated altitude (O_2 = 13.4%). Non-stimulated whole saliva samples were collected for all subjects before and after the exercise. Blood lactate, oxygen saturation and heart rate were measured to assess the anaerobic character of the test.
Results. — The results revealed an increase in salivary pH values after the exercise, only reaching significance for altitude conditions (T2, $P = 0.009$; T3, $P = 0.026$). No significant differences in blood lactate were detected when comparing the three experimental conditions.
Conclusions. — Our results suggest that exercise performed in normobaric hypoxia has stronger effects in saliva alkalinization than when performed under normoxia. As salivary pH is strongly associated with caries incidence, more research is needed to assess the clinical significance of changes in salivary pH due to intense exercise in normobaric hypoxia.

* Corresponding author.
E-mail addresses: gviscor@ub.edu, gviscor@gmail.com (G. Viscor).

http://dx.doi.org/10.1016/j.scispo.2013.12.004
0765-1597/

MOTS CLÉS
pH salivaire ;
Exercice ;
Hypoxie ;
Métabolisme anaérobique

Résumé
Objectifs. — Le but de notre étude était de déterminer si l'exercice de haute intensité réalisé en hypoxie peut affecter la réponse du pH salivaire par rapport à la normoxie.
Sujets et méthodes. — Huit sujets ont participé à un protocole simple et aléatoire à l'aveugle. Le protocole d'exécution composé de six séries de cycles d'étirement-raccourcissement, de 15 secondes d'écart, sous trois conditions différentes : (T1) test de référence à 550 m d'altitude, (T2) en simulation d'altitude 2500 m (O_2 = 16,4 %) et (T3) à l'altitude simulée 4000 m (O_2 = 13,4 %). Des échantillons de salive non stimulées ont été recueillies avant et après l'exercice. Le lactate de sang, la saturation en oxygène et la fréquence cardiaque ont été mesurés afin d'évaluer le caractère anaérobique de l'essai.
Résultats. — Nos résultats ont révélé une augmentation des valeurs de pH salivaire après l'exercice, atteignant la signification statistique pour des tests développés en altitude (T2, p = 0,009 ; T3, p = 0,026).
Conclusion. — Nos résultats suggèrent que l'exercice en hypoxie normobarique provoque une alcalinisation accrue de la salive que lorsqu'elles sont réalisées sous normoxie. Le pH salivaire étant fortement associé à l'incidence des caries, des recherches supplémentaires sont nécessaires pour évaluer la signification clinique des modifications de pH salivaire dû à un exercice intense en hypoxie normobarique.

1. Introduction

Saliva is an important fluid with essential functions in maintaining oral health, digestive process and antimicrobial function [1]. It is well known that low salivary pH values are correlated with higher risk of dental caries, because of the tooth surface demineralization [2]. Thus, when there are low pH values, saliva plays an important role in the protection against dental caries, because of the surface remineralization through buffer mechanisms [3].

Different physiological situations can increase [4] or decrease [5] salivary flow. In addition, stress and physical aerobic [6,7] and anaerobic exercise [8—10] can modify quantitative and qualitative salivary parameters.

Hypoxia is an environmental factor that causes severe physiological stress on the human body, and the effects of altitude exposure have been widely described [11,12]. When altitude increases, a higher contribution of the anaerobic pathways to provide mechanic energy may occur [13], thus increasing the glycolysis mechanisms [14]. After performing exercise at altitude, improved buffer capacity in muscles [15], due to higher tolerance to anaerobic metabolites [16] and indeed an improvement in the heart rate recovery index [17] have been described. Regarding the responses of salivary pH to exercise performed in hypoxia, we have not found previous reports studying the salivary pH trend to high intensity exercise performed at different altitudes.

We hypothesized that anaerobic exercise itself, likely increased by an excessive oxygen debt generated in hypoxia, would change saliva composition and therefore salivary pH. The main aim of this study was to evaluate salivary pH before and after performing high intensity anaerobic exercise bouts (i.e. six sets, each lasting 15 seconds, of stretch-shortening cycles jumping [CMJ15]) in normoxia and at moderate (2.500 m) and high (4.000 m) simulated altitudes.

2. Methods

2.1. Subjects

Eight healthy, non-smoking, and physically active subjects were enrolled to participate in the study (Table 1). Subjects were advised not to consume any kind of food or drink but water during the 1-h period prior to the test, according to the required time to normalize the salivary pH after the food intake [18]. All subjects signed a consent form agreeing to participate in the study, which was according the Declaration of Helsinki as modified by the 59th WMA General Assembly, Seoul, Korea, October 2008. The study was carried out at the Department of Sport Science (Medical Section) of the Innsbruck University.

2.2. Study design

The study involved three experimental sessions (T1, T2, and T3), with at least three recovery days between successive tests. The exercise consisted of six sets of 15 seconds stretch-shortening cycles (SSC) jumping according to Bosco protocol [19] at a different simulated altitudes. A hypoxicator (b-cat HA6500 M, Tiel, Netherlands) was used to produce

Table 1 Anthropometric data of the subjects.

Characteristics	Total (n = 8)
Age, yrs	33.62 ± 4.07
Height, m	1.77 ± 0.05
Weight, kg	74.38 ± 6.86
BMI, kg/m^2	23.75 ± 2.17

BMI: body mass index.