Plasma Metabolic Profiles of Elite Rowers Response to the Early Phase of Altitude Training Based on LC-MS

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Objective When arriving at altitude, because of the dry air, strong ultraviolet and especially the low oxygen et.al., athletes who living on the plain always exhibited kinds of stress reactions such as hyperventilation, tachycardia, dizziness, sleep-disorder, gastrointestinal disturbance and cognitive impairment in the early phase. Except these stress reactions, some studies reported the carbohydrate and lipid metabolism show significant change. Acute exposure to hypoxia could strengthen the glycolysis and suppress hepatic gluconeogenesis. The expression of some genes involved in lipid oxidation was down-regulated. However, it's also found the increased activity of some enzymes took part in aerobic metabolism in muscle after long term acclimatization to altitude. These inconsistent conclusions make us confusion. Train load is an important factor influence the stress reactions which isn't like as altitude travel for normal people. What would happen in the body of athletes when altitude training? We still know very little. Metabonomic give us a new tool to understand the whole map of body's reaction to altitude training. In this pilot study, we aimed to explore the plasma profiles changes of elite rowers in the early two-weeks training at 2300m plateau using metabolic tool based on LC-MS.

Methods Sixteen male elite rowers(age 25.56±3.44y, height 189.06±5.37cm, weight 82.81±12.25kg, training years 10.31±2.52y) from China National team took part in this research. This altitude training camp was organized in the preparation period of a new season. It lasted six weeks. The acute phase (AP) which was the first three days after arriving at 2300m altitude base was composed by regenerative training and low-intensity aerobic training sessions. During the next ten days (chronic phase, CP), the intensity of most sessions including three low-weight resistance training sets were low to middle aerobic. After resting half day, 5 ml venous blood was collected into heparin anticoagulant tubes and then centrifuged at 8000rpm in 4℃ lasting 15 minutes to separate plasma in the 4th day and 14th morning. Plasma was stored in -80℃ to measure metabolic profile by LC-MS. The data was performed feature extraction and preprocessed with Compound Discoverer 2.0 software (Thermo), and then normalized and edited into two-dimensional data matrix by excel 2010 software, including Retention time(RT), Compound Molecular Weight (compMW), Observations(samples) and peak intensity. The feature data after editing were performed Multivariate Analysis (MVA) using SIMCA-P software (Umetrics AB, Umea, Sweden).

Results Compared with pre-altitude, 26 and 30 features at (ESI+) ion mode, 57 and 49 features at (ESI-) ion mode were found in the AP and CP respectively. Compared AP with CP, there were 46 features at (ESI+) ion mode and 67 features at (ESI-) ion mode. In AP, plasma benzamide and indole-3-acetaldehyde increased 35.16 fold and 16.54 fold respectively. Plasma phenethylamine, phenol, indole, piperidine, leucine, 4-chlorbenzoic acid and benzoic acid increased 4.55 to 8.22 fold compared with pre-altitude. Top three decreased features were dibutyl sebacate, arbinosylhypoxanthine and cholesterol hydrogen sulfate which decreased 1.76 to 3.85 fold in AP. After a longer adaption, in the 14th day of altitude training, plasma benzamide, indole-3-acetaldehyde, phenethylamine, indole, 4-chlorbenzoic acid and benzoic acid still increased but the amplitude reduced compared with the 4th day. Ingenuity Pathways Analysis (IPA) suggested that the top 5 canonical pathways were tyrosine biosynthesis IV, phenylalanine degradationI, protein kinase A signaling, tRNA charging and phenylalanine degradation IV in AP. In CP, the top 5 canonical

pathways were tRNA charging, urate biosynthesis, tryptophan degradation X, guanosine nucleotides degradation III and adenosine nucleotides degradationII.

Conclusions In this pilot study, we found 83 and 79 plasma feature in acute and chronic phase respectively. Considering the sharp elevation, plasma benzamide and indole-3-acetaldehyde which involved in the regulation of energy metabolism of brain may be the sensitive makers in acute adaption to altitude for athletes. As the extension of time, the increased amplitude came down in the 14th day. It suggested that the energy metabolism of brain may take significant change. Central nerve system should be paid more attention during altitude training especially in the early phase.