The potential role of phenotypic plasticity in the adaptation of nasal turbinates to cold environment

Louise Magne[1], Laura Maréchal[1], Maureen J. Devlin[2], and Yann Heuzé[1]
[1]PACEA, UMR5199, Univ. Bordeaux, CNRS, MC, [2]Department of Anthropology, University of Michigan

In humans, the nasal region is the main area of the craniofacial skeleton displaying clear signs of environmental adaptation (temperature, humidity). However, the evolutionary mechanisms supporting such adaptation remain debated including the potential role played by phenotypic plasticity. A recent study showed that beside the nasal aperture and cavity, the inferior nasal turbinates also exhibit ecogeographic variation. Inferior turbinates contribute to homeothermy and water conservation. Individuals living in cold-dry climate tend to possess larger inferior turbinates enhancing air conditioning capacity. To explore the potential role of phenotypic plasticity in such adaptation, male C57BL/6J inbred laboratory mice were exposed from 3-12 weeks of age to 10°C, 22°C, and 26°C (N=8/group). The mice were sacrificed at the age of 12 weeks and subsequently micro-CT scanned. The left respiratory turbinates were segmented and their volume (V), surface area (SA), and SA/V ratio automatically computed. The volume of the inferior respiratory turbinate (i.e. maxilloturbinate, MT) was significantly larger in mice exposed to 10°C (ANOVA $F=3.88$, $p=0.0376$). Mice raised at 10°C exhibited a significantly lower MT SA/V ratio (ANOVA $F=6.05$, $p=0.0094$). Our results support the hypothesis that inferior turbinate phenotype has developmental plasticity in response to temperature. Indeed, similar to humans, mice exposed to cold exhibit larger inferior turbinates. However, more work is required to interpret our counterintuitive finding of lower SA/V ratio in cold-housed mice (high SA/V ratio increases thermodynamic exchanges and air conditioning capacity) and the role of phenotypic plasticity in the production of a temperature-adapted phenotype.

This study was partially funded by the French National Agency for Research (ANR) with the program ANR-10- LABX-52 and NSF BCS-1638553