The relationship of cranial, orbital and nasal cavity size with the morphology of the supraorbital region in modern Homo sapiens

Wioletta Nowaczewska1,*, Urszula Łapicka1, Agata Cieślik2 and Przemysław Biecek3

1 Department of Human Biology, Wrocław University, Kuźnicza 35, 50–138, Wrocław, Poland
2 Hirszfeld Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Unit of Anthropology, Podwale 75, 50–449, Wrocław, Poland
3 Faculty of Mathematics and Information Science Warsaw University of Technology, Koszykowa 75, 00–662 Warszawa
* Corresponding author: wnowacz@wp.pl; wioletta.nowaczewska@uwr.edu.pl

With 2 figures and 6 tables

Abstract: Morphological variation of the supraorbital region (SR) in human crania has been investigated and its potential sources suggested, along with the importance of the size of the facial skeleton, neurocranium, and orbit for the formation of this region. However, previous studies have not indicated whether facial size exhibits a stronger association with SR robusticity than neurocranial size or sex; moreover, the association between orbital volume and SR robusticity has been analysed only in non-human primate skulls. In this study we investigate whether the size of the facial skeleton, neurocranium, two measures of relative orbital size (orbital volume and estimated orbital aperture area), the relative size of the nasal cavity, and the relative estimated area of the anterior nasal cavity opening are related to SR robusticity; we also examine which of these analysed relationships is strongest, as well as independent of the influence of the other traits, in a geographically diverse modern human cranial sample. The results of Spearman’s rank and partial rank correlations (encompassing models including or excluding sex and geographic origin) show a relationship between most of the above-mentioned variables and SR robusticity, with the exception of the estimated relative area of the orbital opening (in the case of the results of Spearman’s rank correlations) and the traits of the nasal cavity. Of all the analysed traits, sex appears to be the most important for the formation of SR robusticity and, of two measures of cranial size, neurocranial size was the most significant. The strong relationship between SR robusticity and relative orbital volume was observed in models without the geographic origin factor. The results concerning analysed models suggest the influence of this factor on this relationship; however, to explain this influence, further studies are needed.

Keywords: robusticity glabella; superciliary arch; cranial size measures; orbital volume; geographic origin

Introduction

Four morphological features of the supraorbital region (SR) of the frontal bone are distinguished in the cranium of modern Homo sapiens: the medial region above the nasal bones, described as the glabella; the superciliary arch located laterally from the glabellar region; the supraorbital trigone, defined as the most lateral area of the orbital margin between the supraorbital notch and the zygomatic process of this bone; and the supraorbital sulcus, separating the superciliary arch from the supraorbital trigone (Cunningham 1908; Vinyard & Smith 1997) (Fig. 1). The SR is the inferior part of the frontal bone; its external surface forms the upper part of the facial skeleton (Moss & Young 1960; Athreya 2012). The SR is enlarged through drift of the external table of the frontal bone (growing in a trajectory characteristic of the rest of the facial skeleton) relative to the internal table of this bone (growing in a neural trajectory as an element of the neurocranium); thus it ‘combines’ elements belonging to the neurocranium and the splanchnocranium (Lieberman 2000; Lieberman 2011).

Although some hypotheses have been proposed concerning the formation/sources of morphological variation of the SR in the cranium of Homo sapiens, there is no commonly accepted view as to which set of factors fully explains the differences in the degree of development (robusticity) of the SR in modern and/or fossil humans (see Athreya 2012). Among the proposed hypotheses are biomechanical models (Endo 1970; Russell 1985; Hilloowala & Trent 1988), cortical thickness models (Hublin 1987; Lahr & Wright 1996), structural