Anthropological variables as economic indicators

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Anthropological studies of human populations are traditionally aimed at identifying the relative contributions of the genetic, physiological and cultural mechanisms underlying the geographical micro-differentiation and adaptation of populations to the different environments in which they live. According to this approach, all anthropological variables are subjected to environmental pressures and can present variations of their frequencies among different populations. Some of them are of particular interest since, despite a strong genetic component, they show greater eco-sensitivity than others. Their variability in the passage from one generation to another is interpreted as phenotypically influenced by the environment in which the individuals grow. Some examples are stature, weight, and the timing and modes of pubertal development.

The literature produced in regard to this issue is extensive and it is, mainly, the result of studies on conscripts series, in the case of stature, and field research projects conducted on single populations that refer to a specific moment or to limited periods of time (Baynouna *et al.*, 2009; Jacobs & Tassenaar, 2004; Malina *et al.*, 2010; Ji & Chen, 2008; Webb *et al.*, 2008; Stock & Migliano, 2009). Thus, the evaluation of the biological history of most populations in relation to their ecological contexts is prevented, except in the case of the studies on conscripts series.

The contemporary interest of both economists and demographers in the analysis of anthropometric data, namely of height, for the reconstruction of socioeconomic trends in Countries and/or periods lacking of any other kind of informative source, highlighted new possible insights in anthropological studies conducted by utilizing, not only stature, but all body measurements. This is due to the methodological introduction of analysing the data by age cohorts, generally 5 or 10 years age classes, that allows splitting the samples in several generations, thus following the evolution of body dimensions in several generations.

It is within this context that the Italian Institute of Anthropology (*www.isita-org.com*) promoted a research project aimed at the recovery and digitization of anthropometric data collected by Italian anthropologists in many surveys conducted worldwide during the 20th century. The ultimate goal of the project is to contribute to the reconstruction of the biological history of these populations through estimates of the variations in space, namely microgeographic differentiation, and in time, namely the secular trend, of several anthropological parameters.

The case study

As a general example of the anthropological approach we will discuss the outcome of the analysis of several body measurements of adult Libyan males dating to the 1930s. The data were collected by Puccioni in 1928-29 (Puccioni, 1936) and refer to people settled in Cyrenaica
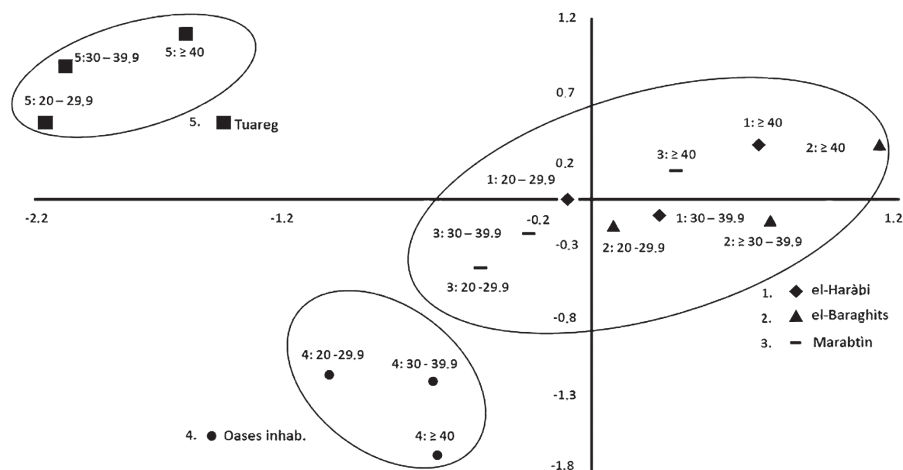
Fig. 1 - Morphometric distances among the five ethnic groups by age classes.

(Nort-East), and by Cipriani (Moggi Cecchi, priv. coll.) on a group of Tuareg settled in Fezzan. The global dataset consisted of 745 adult males belonging to 5 ethnic groups: el-Haràbi (n = 301), el-Baraghìts (n = 159), Marabtìn (n = 184), Oases inhabitants (n = 37) and Tuareg (n = 64). The detailed description of the sample, of the anthropometric parameters (n = 12) and of their reliability can be found in Danubio *et al.* (2011).

In that paper the authors followed the traditional approach of evaluating the morphometric distances among the different groups and the occurrence of the secular trend in the different age cohorts in two separate steps (Jelenkovic, *et al.*, 2008; Martinez-Abadias, 2009). The first step consists in comparing the mean values of body dimensions among the total samples of the ethnic groups and by means of the cluster analysis applied to the craniofacial morphometric measurements only, the less '*environment sensitive*' variables. The results of this first step showed statistically significant differences among the five groups, essentially due to the Tuareg, on one side, and the inhabitants of the Oases, on the other. Concerning height in particular, the Tuareg had the highest mean values:171.1 cm, and the inhabitants of the Oases had the lowest: 162.9 cm. No appreciable differences were found

among the el-Haràbi, the el-Bagarìts and the Marabtìn groups whose height averaged 168.0 cm. The analysis of the secular trend was performed only on body dimensions, considered the more '*environment sensitive*' variables. Each ethnicity was analysed by 10 years age classes, thus three age groups were considered: 20.0-29.9, 30.0-39.9 and 40.0-over years old. Result of this second step showed slight variations in time of mean values of all considered variables in all ethnic groups. Furthermore, the observed variations were towards the stasis or light decreases from the oldest to the youngest. These common tendencies suggested that, although different culturally and geographically, these ethnic groups were all experiencing similar life conditions.

The statistical approach

In the present forum we want to present and discuss results obtained by analyzing the same database by means of multiple discriminant analysis in order to check for comparable results. This methodology analyses the relationships among different populations and allows the classification of the individuals by estimating their probability of belonging to one given group.

The method allows the multiple measurements to be reduced to one or more canonical variates, i.e. weighted combinations having maximum potential for distinguishing among members of the different groups. The first canonical variate is that single weighted composite which of all possible weighted composites provides maximum average separation between the groups relative to variability within the groups. The second canonical variate is that weighted composite which, of all possible weighted composites uncorrelated with the first, provides for maximum average separation among the groups.

In this case multiple discriminant analysis in standard procedure was performed utilizing the data of all 12 anthropometric variables to evaluate both the relations between the five ethnic groups and the observed differences among the considered age classes of each ethnic group. All statistical analyses were carried out with SPSS, version 16.0. The obtained value of Wilks' lambda: 0.3225, approx. F (182, 6911) = 4.756, p< 0.0001, indicates heterogeneity among the ethnic groups, divided by age. The first and the second function explain 46.81% and 16.34% of the total variation, respectively. Examination of standardized discriminant coefficients suggests that biiliocristal breadth and biiliocristal/height ratio have the maximum influence on the first discriminant function, whereas the variables with the highest loadings for the second function are head breadth and head breadth/head length ratio (detailed results available upon request). The centroids of the Lybian ethnic groups, divided by age, derived from the standard discriminant analysis of twelve anthropometric measures are shown in Figure 1. The first canonical variate clearly separates the Tuareg group from the others group, while the second variate separate the Oases group. The other ethnic groups are generally close to one another. In summary, the Oases inhabitants and the Tuaregs cluster separately one from the other and both from the other three ethnic groups. The el-Harabi and el-Baraghìts, considered descendants of the ancient Arabs, and the Marabtìn, considered descendants of the ancient Berbers, show no appreciable morphometric differences as they tend to cluster closely together. Differences among groups are greater among the older (age category ≥40.0) than the younger (age category 20.0-29.9 years).

Final remarks

The above results appear to be perfectly comparable to those reported by Danubio *et al.* (2011). In fact, the multiple discriminant analysis shows the morphometric similarity of the el-Harabi, el-Baraghìts, and the Marabtìn groups, opposed to the Tuareg, on one side, and the Oases inhabitants, on the other. Moreover, the inhabitants of the Oases show lower diversity from the el-Haràbi, el-Bagarìts and Marabtìn groups in the younger than the Tuareg who maintain their diversity throughout the three generations. Similarly, when considering the different age cohorts, it emerges that within-group variations are not very marked in all ethnicities. However, the general tendency to reduction/stagnation of body dimensions from the older to the younger is evident. Finally, it is noteworthy that these results were obtained with the simultaneous use of all body dimensions, those considered 'more genetically' determined together with the 'more environmentally sensitive' ones.

In conclusion, multiple discriminant analysis applied to anthropometric variables is a valid tool for the study of variations in time and space of bioanthropological variables aimed at estimates of both the microgeographic differentiation of different ethnic groups and the occurrence of their secular changes through generations.

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