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Human Skeletal Diversity in the Egyptian Nile Valley

Abstract

This paper examines the biological diversity found within a series of Middle and Upper Egyptian Predynastic skeletal populations. Computed adult stature is shown to increase significantly through the Predynastic to reach a maximum in the Early Dynastic period. This stature increase is shown to be the result of significant change in the length of the distal limb segments.

Stature increase can be the result of changes in growth pattern or the result of changes in population composition. The second portion of this paper therefore considers the craniometric evidence for changes in population affinity through the Predynastic period.

Introduction

Many studies have considered the evidence for changes in Egyptian funerary ritual and mortuary architecture (e.g. Bard 1994; Castillos 1998; 2000a; 2000b; Ellis 1992; Grajetzki 2003; Meskell 1997; Richards 1997). There have, by contrast, been few studies that have attempted to use the actual skeletal evidence in order to answer the same questions as to population diversity and temporal change (as summarised in Smith 2002). The biological characteristics of modern Egyptians have been shown, through DNA, blood groups, serum proteins, to exhibit a north-south cline with similarities to sub-Saharan and Levantine groups (Fox 1997; Krings et al. 1999; Pääbo & Di Rienzo 1993).

The present study attempts to readdress the balance of studies towards osteology and to examine the biological changes associated with the development of a complex social hierarchy within a series of time-successive Egyptian Nile Valley skeletal populations. This study assumes indigenous state formation processes.

Human growth, infection and social hierarchy

Human growth is an outcome of complex interactions between genes and the environment, of which nutrition and infection are the most important components. The development and intensification of agriculture usually leads to an increase in the prevalence and intensity of infectious disease, linked to the associated increase in population density and sedentism (e.g., Cook 1984; Meiklejohn et al. 1984) and may lead to a reduction in the size and robusticity of the adult population (Angel 1972; Larsen 1984), or a reduction in other specific skeletal dimensions (Angel 1984).

Individuals with relatively poor diets suffer proportionally more from the effects of infection, such as poor individuals relative to highly ranked ones in complex state societies. With the development of this complex social ranking, preferential access to food might also develop, and thus might be reflected in each individual's skeletal biology. A series of studies have indicated that, in most past societies, elites were taller, healthier or better fed than the poorer members (Allison 1984; Angel 1984; Cohen 1989; Cook 1984; Haviland 1967; Schoeninger 1979; Steegmann & Haseley 1988), although others have found little or no difference between commoners and elites (White et al. 1993). If the former are correct, it therefore follows that adult stature can be a reasonable indicator of childhood condition.

Previous Studies

A variety of osteological studies of Predynastic and early Dynastic Egyptian skeletal material have been undertaken. Sadly, many of these studies were typological or descriptive, and so cannot be employed for comparative purposes.

Few studies have analysed postcranial material from Egyptian populations. Mean adult statures for Predynastic males have been computed as 170.0 cm (Robins 1983) and 157.5 m for females (Robins and Shute 1984). For all of the Dynastic period, the mean male statures obtained range from 165.8 cm to 168.4 cm, whilst females range from 155.8 cm to 157.5 cm (Grilleto 1979; Masali et al. 1966; Robins, 1983; Robins & Shute 1983, 1984; Volante 1974)

By contrast, many more studies have been undertaken on the Predynastic cranial material (discussed in Keita 1996 and Smith 2002, and hence only briefly summarised here).

Most early (and now discredited) studies concluded that there were two population groups inhabiting Egypt throughout the Predynastic period, and that the northern group (the Lower Egyptian type) replaced the more Negroid southern type during the Dynastic period. Many of these early cranial studies allow for some population admixture with neighbouring areas (e.g. Derry 1956) and use this to explain the increased variance seen in metric variables through time.

More recent studies continue to show a geographic variation in morphology within Egyptian samples. This variation may be due to migrations of people up and down the Nile Valley. For example, Keita (1990; 1992), employing discriminant function analysis, noted the overlap of southern Egyptians and some southern African series.

The Badarian sample frequently appears to be relatively distinct. This could be due to their very gracile nature (Gaballah et al. 1972), with very little development of the muscular relief, so they have often been considered to have a generally "feminine" character (Strouhal 1971: 2). Stoessiger (1927: 121-123) described the group as being distinct from later Predynastic populations through being more dolichocephalic and prognathic, being somewhat narrower in the parietal region, and by having shorter faces (and a lower nasal index). In contrast, Strouhal (1971: 2) considered them to have high nasal indices. He also described them as narrow, average height skulls with average to narrow upper faces and a rather broad nose, with marked prognathism. It is interesting to note that these biometrical studies led the investigators to consider the Badarian sample to be homogeneous, whilst the excavators (Brunton and Caton-Thompson) considered them to be heterogeneous (Strouhal 1971: 3).

Although the Badarian crania are considered by biometricians to be homogeneous, this homogeneity may break down by the later Predynastic period, and has certainly broken down by the early Dynastic period, e.g. the cranial material from the Royal Tombs sample at Abydos had a markedly heterogeneous appearance (Keita 1992: 248).

Materials and Methods

The selection of skeletal material was mainly pragmatic. For most periods, all available material was assessed, although complete skeletons were preferred over crania alone, and complete crania were selected in preference to fragmentary material. Care was taken to maximise samples from all available time periods. The sampling was also limited by the selection of the material that had been removed from Egypt and thus available for study in museum and university collections. This means that the material may not be completely representative of the cemetery population, but it should be noted that the cemetery population may itself not be truly representative of the living population (Wood et al. 1992).

Three collections were studied; the Duckworth Collection of the Department of Biological Anthropology in Cambridge, the Egyptian collection of the Natural History Museum in London and the Marro Collection of the Department of Anthropology and Biology in Turin.

A series of four time period groups were studied, dating from the Badarian to the early Dynastic. The temporal groups were: Badarian, early Predynastic (EPD), later Predynastic (LPD) and early Dynastic (EDynastic). The use of EPD and LPD was undertaken as the samples could not be securely dated to Naqada periods and so were split into these two broader temporal periods.

Samples were studied only if they could be reliably dated to one of the periods. Analysis was limited to adult individuals, with maturity being determined on the basis of spheno-occipital fusion, full epiphyseal fusion and complete eruption of the third molars.

Table 1. Skeletal Samples Employed

Time Period	Site(s)	*N* (total)	*N* (♂)	*N* (♀)
Badarian	El-Badari	49	22	27
EPD	Abydos, El-Amrah & Gebelein	80	39	41
LPD	El-Amrah & Hierakonpolis	72	31	41
EDynastic	Abydos & El-Amrah	97	55	42
Total		298	147	151

Following Howells (1973; 1989), all individuals were assigned a sex, rather than being classified as being 'sex unknown'. The sex of each individual was primarily determined from analysis of the pelvic region, by assessing the size of the pubic angle, the size of the greater sciatic notch, the curvature of the sacrum, noting the presence or absence of ventral arc and subpubic concavity, and the relative lengths of the inferior ramus of the pubis and the distance from the pubic tubercle to the acetabulum. Postcranial sex was compared with the cranially determined sex. Cranial sex was assessed from the degree of supra-orbital and glabellar projection, the squareness of the anterior portion of the mandible, the flaring of the gonial region, the robustness and level of muscle development in the nuchal region, and other features, such as the general size of the cranium with respect to others in the sample. The size of the mastoids was considered, but all the Egyptian cranial material studied has relatively inflated mastoids as compared to other populations. For individuals for whom cranial material alone was available, comparisons were made with individuals of known sex to increase the reliability of the sexing method.

Following sexing, each long bone was measured individually following Martin and Saller (1957) and Bräuer (1988) using a portable field osteometric board. The sample consisted of 462 long bones. Where long bones were bilaterally present, mean measurements were calculated and used in the analyses.

For craniometric measurements, the techniques described by Howells (1973 1989) and Lahr (1996) were employed. A spreading calliper was used to take the measurements where both landmarks for a single measurement had to be instrumentally determined, such as maximum cranial breadth (XCB). A digital sliding calliper, with direct data entry to a portable computer, was used to measure directly from one landmark to another, e.g. upper facial height (NPH). A co-ordinate calliper was employed for the measurement of chords, subtenses and fractions, e.g. OCC, OCS & OCF. Measurements from the transmeatal axis were made using a radiometer, such as nasal radius (NAR).

Description of Samples

Material from several cemetery sites was pooled for most periods, so as to diminish the effects of bias due to familial groupings or social ranking. This was not possible for the earliest period, the Badarian, where all the material originates from the period type-site of el-Badari. The EPD material was obtained from Abydos cemetery ϕ, El-Amrah and Gebelein. The LPD material was all from El-Amrah and Hierakonpolis. The EDynastic material mainly originated from Abydos, with some deriving from the Tombs of the Courtiers cemetery, while El-Amrah provided a small sample. The Tombs of the Courtiers sample consists of individuals who may have been funerary priests (Hoffman 1979), minor palace functionaries, members of the royal harem, or artisans (Trigger 1983). This sample therefore may be wealthier and healthier than the average Egyptian EDynastic person. The remainder of the Abydos EDynastic material was derived from Cemetery χ, and may represent a poorer section of Abydos society. The strong links between the town itself and the royal court mean that the EDynastic period material included in this study may be somewhat unrepresentative of the national Egyptian population of the time, as the sample may represent favoured individuals and families.

Data Analysis

The Statistical Package for the Social Sciences (SPSS, version 11.0) was used for the data analysis described below. All variables were tested for normality using P-P and Q-Q plots (Sokal & Rohlf 1995: 118), with a normal distribution being observed in all the variables selected for analysis.

Stature, raw long bone lengths and ratios (indices) were analyzed using univariate analysis of variance, employing a type I (hierarchical or nested) model (Sokal & Rohlf 1995: 272-309), with post-hoc tests, for differences among the various time periods, while correcting for sex. The model allows differences between the sexes to be analyzed first, and after the effects of sex are removed, to assess for statistically significant differences among the various time periods. Thus, in all the postcranial analyses that follow, the independent variable in each ANOVA is the time period (i.e., population group, such as Badarian or EPD). Throughout the analyses an α-level of 0.05 was employed.

Due to the rather small sample sizes of some time periods under consideration and the relatively fragmentary nature of the crania during these periods, initial cranial analyses were performed on pooled sex samples.

The multivariate analyses undertaken are principal components analysis (PCA) and discriminant function analysis (DFA). PCA is a form of factor analysis that aims to identify the underlying factors (variables) explaining the pattern of correlations within the set of observed variables. It can therefore be employed to ascertain which variables are of greatest importance in explaining the variance seen within the ellipse of data points in multidimensional space.

By contrast, the purpose of DFA is to assign group membership from a number of predictors, thus in this study it has been used to assess whether cranial variables can be used to predict the time period group membership of the cranial sample. The main aim is, therefore, to find the dimension or dimensions by which the groups differ and then derive classification functions from this to predict group membership. DFA forms a string of functions and judges whether the groups it predicts from these functions match the imposed groups within the data. Thus, in DFA, the raw measurements for each individual are converted into functions relating to cranial dimensions. A coefficient (weighting) is given to each measurement (variable) and the individual's actual measurement is multiplied by this coefficient. The sum of these weighted measurements comprises the individual's 'discriminant score'. The number of discriminant functions obtained is always one fewer than the number of groups imposed on the data (4 time periods and hence 3 functions).

Stature and Body Morphology Results

Stature was computed using equations derived by Robins and Shute (1986) specifically for Egyptian populations. The computed adult statures are shown in Fig. 1. Table 2 presents the hierarchical ANOVA results for computed mean stature by time period. Males are shown to be significantly taller than females in all time periods and, overall, a significant change in stature occurs across the time periods studied.

Raw long bone lengths were also analysed in order to assess whether any portion of the body showed statistically significant change in size using the same hierarchical ANOVA method (Table 3). This table indicates that most change in length occurred within the distal segment of each limb, although there was also some change in humeral length. Ratios of long bone lengths were also analysed to assess for change in body plan, but only the femoral-fibula ratio (100*XLF/XLG) exhibited statistically significant change through the time (n = 24, p=0.023).

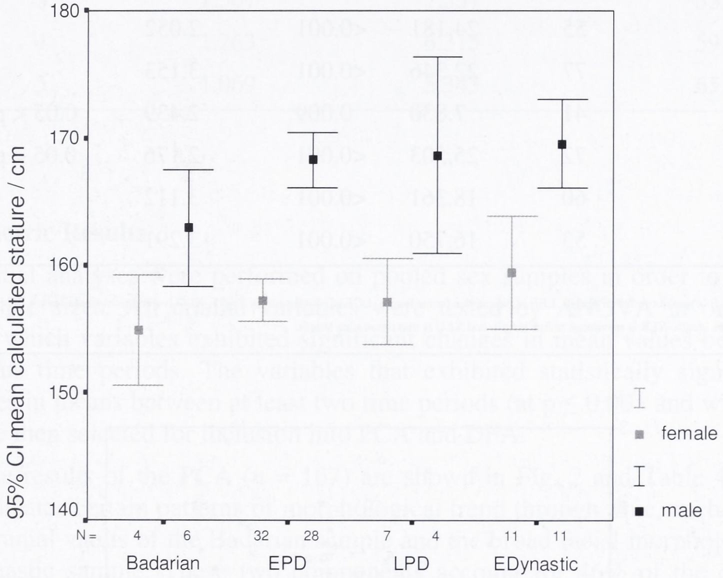

Fig. 1. Average computed adult stature by time period for each sex. Mean values, sample sizes and 95% confidence intervals are shown.

Table 2. ANOVA results for computed mean stature by time period, employing hierarchical model correcting initially for sex.

Source	Type I Sum of Squares	df	Mean Square	F	p
Sex	2786.075	1	2786.075	107.346	< 0.001
Time Period	234.323	3	78.108	3.009	0.034
Sex * Period	22.085	3	7.362	0.284	n.s.
Error	2465.638	95	25.954		
Total	2724908.210	103			

$R^2 = 0.552$

Table 3. ANOVA results for long bone lengths by time period, employing hierarchical model correcting initially for sex.

Measurement	*N*	Sex		Time period	
		F	p	F	p
XLF	55	20.888	<0.001	1.771	n.s.
LBF	55	24.181	<0.001	2.052	n.s.
LCT	77	22.346	<0.001	3.153	0.030
XLG	41	7.830	0.009	2.439	0.05 < p < 0.10
XLH	72	25.503	<0.001	2.176	0.05 < p < 0.10
XLR	60	18.361	<0.001	3.112	0.034
XLU	53	16.750	<0.001	3.291	0.029

Where XLF is maximum femur length, LBF is bicondylar femur length, LCT is complete tibia length, XLG is maximum fibula length, XLH is maximum humerus length, XLR is maximum radius length, and XLU is maximum ulna length.

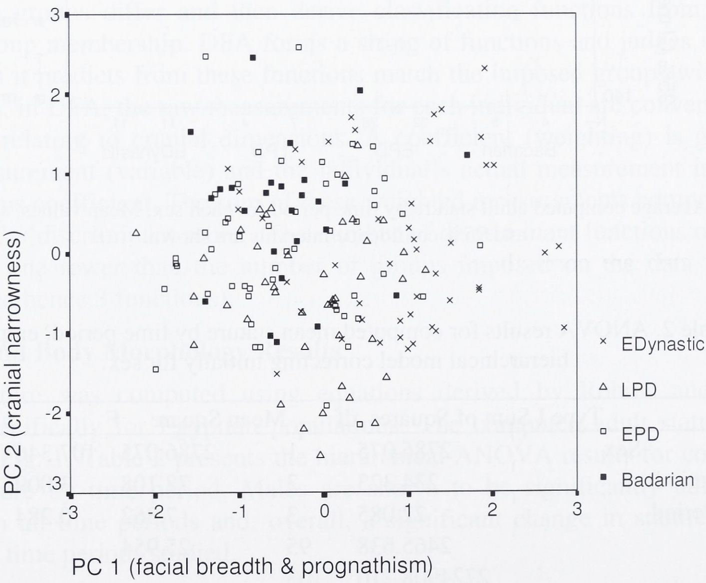

Figure 2. PCA results – plot of first two principal components, sexes pooled.

Table 4. Amount of variance explained in the extracted PCs, sexes pooled.

Component	Eigenvalue	% of Variance	Cumulative %
1	7.287	36.436	36.436
2	1.928	9.642	46.078
3	1.507	7.537	53.615
4	1.263	6.315	59.930
5	1.069	5.343	65.273

Craniometric Results

Initial analyses were performed on pooled sex samples in order to maximise sample sizes. All cranial variables were tested by ANOVA in order to ascertain which variables exhibited significant changes in mean values between the various time periods. The variables that exhibited statistically significant differences in means between at least two time periods (at $p \leq 0.001$ and with $n \geq 200$) were then selected for inclusion into PCA and DFA.

The results of the PCA ($n = 167$) are shown in Fig. 2 and Table 4. This figure indicates certain patterns of morphological trend through time, such as the narrow cranial vaults of the Badarian sample and the broad facial morphology of the EDynastic sample. These two components account for 46% of the cranial variation seen in the samples studied.

The results of the DFA are displayed in Fig. 3 and Table 5. Overall 70.1% of the crania are correctly classified into their original temporal period. These results indicate that distinct morphological differences exist between the samples. The crania that are misclassified are generally placed into one of the temporally-adjacent groups, suggesting that there is population continuity through time.

Analyses were also undertaken on single sex groups using the same methods described above. Following Keita (1990; 1992; 1996), only the results for males will be discussed here. The classification results for the DFA using cranial variables found to exhibit statistically significant differences between at least two time periods (at $p \leq 0.001$ with $n \geq 100$) are shown in Table 6, below.

Overall 72.5% of the male crania ($n = 91$) were correctly classified into their original temporal group.

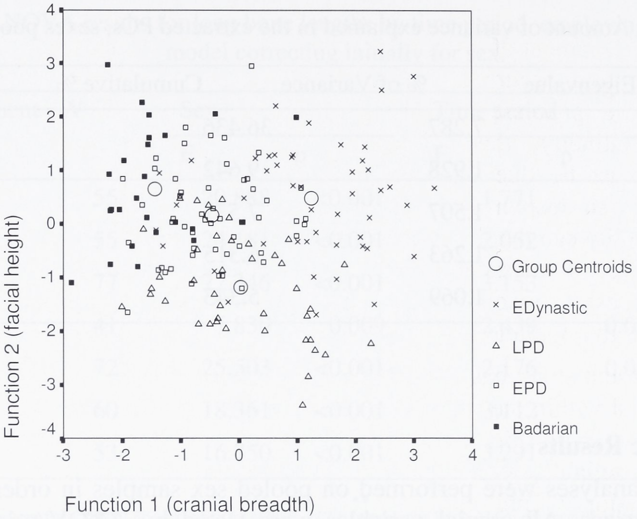

Figure 3. Plot of first 2 DFs, sexes pooled.

Table 5. Percentage of crania correctly classified by time period, sexes pooled.

Original	Predicted Group Membership			
Group	Badarian	EPD	LPD	EDynastic
Badarian	**57.7**	30.8	7.7	3.8
EPD	7.7	**71.2**	9.6	11.5
LPD	2.4	19.5	**73.2**	4.9
EDynastic	8.3	8.3	10.4	**72.9**

Table 6. Percentage of crania correctly classified by time period, males only.

Original	Predicted Group Membership			
Group	Badarian	EPD	LPD	EDynastic
Badarian	**54.5**	18.2	18.2	9.1
EPD	13.0	**65.2**	13.0	8.7
LPD	.0	19.2	**76.9**	3.8
EDynastic	.0	6.5	12.9	**80.6**

Discussion

The development of intensive agriculture and the formation of hierarchical social organization occurred almost simultaneously along the Egyptian Nile valley. If these processes occurred as indigenous development with total population continuity, then biological changes found within the skeletal populations must be due either to functional and adaptive plasticity, or to microevolution in response to changing selective pressures. An increase in skeletal variability can therefore be assumed to be the result of a great increase in population size, a massive increase in social hierarchy with associated differential access to resources, or due to migrations of groups or individuals within the overall population.

The present study has shown that a significant increase in computed adult stature occurred within the samples studied between the Badarian period and the Early Dynastic period (Fig. 1 and Table 2). This suggests that as food resources became more reliable, with greater organisation of food production, that any growth retardation or inhibition associated with the development of agriculture was reduced or removed. By implication, this suggests that the Badarian sample may have suffered from some mechanism, such as unreliable food supply, that inhibited certain periods of childhood growth.

Recent research has indicated that sexual dimorphism in computed adult stature increased through the Predynastic periods, to reach a maximum in the LPD, following by a decline during the Early Dynastic (Zakrzewski 2003: 223). The coefficient of variation in computed stature is, by contrast, greatest during the EPD (Zakrzewski 2003: 223-224). These results suggest that differential access to resources may have developed during the Predynastic periods, with initial social hierarchy developing in the EPD, followed by more complex ranking, including differential gender relations during the LPD. Thus, during the Predynastic population postcranial variability increased dramatically, with this variation being both an increase in sexual dimorphism, and also being within each sex.

The craniometric research presented here indicates that there were distinct morphological groups within the Egyptian Predynastic population, but that these groups do exhibit morphological similarities with each other. The Badarian sample has again been shown to be relatively homogeneous, supporting previous studies, whilst the EDynastic sample has been shown to be more heterogeneous, but characterised by broad faces. The morphological groups found, therefore, may represent either temporal variation or geographical variation, and thus indicates that there was not the "total population continuity" postulated. The change observed from the Badarian period through the Predynastic periods thus probably reflects increased gene flow via exogamy or migration along the Nile

Valley (as postulated by Hassan 1988) and mirrors the results obtained by Keita (1996). The change between the LPD and the EDynastic, however, appears more fundamental and could reflect even greater migration of individuals along the Nile Valley. The analyses also indicate greater cranial diversity through time, which may be the result of the associated population increase.

The results however do indicate that Egyptian populations should not be considered as a homogeneous entity, but rather should be viewed as local groups with reasonably distinct identities. This research has also indicated that the State formation process cannot simply be modelled as an entirely indigenous development, but rather that neighbouring groups (both from elsewhere along the Egyptian Nile Valley and from nearby regions) appear to have also interbred and mixed with the local population.

Conclusion

This paper has demonstrated that high levels of skeletal variability developed during the Egyptian Predynastic. It has shown that the Badarian population was relatively homogeneous morphology, and has contrasted them with the more heterogeneous nature of the EDynastic sample.

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References

ALLISON, M.J. 1984. Paleopathology in Peruvian and Chilean Populations. In: M.N. Cohen and G.J. Armelagos (eds) 1984: 515-529.

ANGEL, J.L. 1972. Biological Relations of Egyptian and Eastern Mediterranean Populations during Pre-dynastic and Dynastic Times. *Journal of Human Evolution* 1: 307-313.

ANGEL, J. L. 1984. Health as a Crucial Factor in the Changes from Hunting to Developed Farming in the Mediterranean. In: M.N. Cohen and G.J. Armelagos (eds) 1984: 51-74.

BARD, K.A. 1994. *From Farmers to Pharoahs*. Sheffield: Sheffield Academic Press.

BRÄUER, G. 1988. Osteometrie. In: R. Knussmann (ed.), *Anthropologie: Handbuch der Vergleichenden Biologie des Menschen:* 160-232. Stuttgart: Gustav Fischer.

CASTILLOS, J.J. 1998. Tomb Size Distribution in Egyptian Predynastic Cemeteries. *Discussions in Egyptology* 40: 51-65.

.... 2000a. The Predynastic Cemeteries at Mostagedda. *Göttinger Miszellen* 175: 23-28.

.... 2000b. Social Development in Predynastic Egypt: Matmar, a case study. In: L. Krzyżaniak, K. Kroeper and M. Kobusiewicz (eds), *Recent Research into the Stone Age of Northeastern Africa*: 159-170. Poznań: Poznań Archaeological Museum.

COHEN, M.N. 1989. *Health and the Rise of Civilization*. New Haven: Yale University Press.

COHEN M.N. and G.J. ARMELAGOS (eds). 1984. *Paleopathology at the Origins of Agriculture*. New York: Academic Press.

COOK, D.C. 1984. Subsistence and Health in the Lower Illinois Valley: Osteological Evidence. In: M.N. Cohen and G.J. Armelagos (eds) 1984: 237-270.

DERRY, D.E. 1956. The Dynastic Race in Egypt. *Journal of Egyptian Archaeology* 42: 80-85.

ELLIS, C. 1992. A Statistical Analysis of the Protodynastic Burials in the „Valley" Cemetery of Kafr Tarkhan. In: E. van den Brink (ed.), *The Nile Delta in Transition: 4th - 3rd Millennium BC*: 241-258. Jerusalem: Israel Exploration Society.

FOX, C.L. 1997. mtDNA Analysis in Ancient Nubians Supports the Existence of Gene Flow Between Sub-Sahara and North Africa in the Nile Valley. *Annals of Human Biology* 24(3): 217-227.

GABALLAH, M.F., M.T. EL-RAKHAWY et al. 1972. On the Craniological Study of Egyptians in Various Periods. *Anthropologie* X/2(3): 29-33.

GRAJETZKI, W. 2003. *Burial Customs in Ancient Egypt*. London: Duckworth.

GRILLETO, R. 1979. La Stature des Anciens Égyptiens d'Asiut et de Gebelen (Haute Égypte). *L'Anthropologie* 83(3): 455-459.

HASSAN, F.A. 1988. The Predynastic of Egypt. *Journal of World Prehistory* 2(2): 135-185.

HAVILAND, W.A. 1967. Stature at Tikal, Guatemala: Implications for Ancient Maya Demography and Social Organization. *American Antiquity* 32: 316-325.

HOFFMAN, M.A. 1979. *Egypt Before the Pharaohs*. New York: Alfred A. Knopf.

HOWELLS, W.W. 1973. *Cranial Variation in Man: A Study by Multivariate Analysis of Patterns of Difference Among Recent Human Populations*. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University 67.

HOWELLS, W. W. 1989. *Skull Shapes and the Map: Craniometric Analyses in the Dispersion of Modern Homo*. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University 79.

KEITA, S.O.Y. 1990. Studies of Ancient Crania from Northern Africa. *American Journal of Physical Anthropology* 83: 35-48.

.... 1992. Further Studies of Crania From Ancient Northern Africa: An Analysis of Crania From First Dynasty Egyptian Tombs, Using Multiple Discriminant Functions. *American Journal of Physical Anthropology* 87: 245-254.

.... 1996. Analysis of Naqada Predynastic Crania: A Brief Report. In: L. Krzyżaniak, K. Kroeper and M. Kobusiewicz (eds), *Interregional Contacts in the Later Prehistory of Northeastern Africa*: 203-213. Poznań: Poznań Archaeological Museum.

KRINGS, M., A.H. SALEM et al. 1999. mtDNA Analysis of Nile River Valley Populations: A Genetic Corridor or a Barrier to Migration? *American Journal of Human Genetics* 64: 1166-1176.

LAHR, M.M. 1996. *The Evolution of Modern Human Diversity*. Cambridge: Cambridge University Press.

LARSEN, C.S. 1984. Health and Disease in Prehistoric Georgia: The Transition to Agriculture. In: M.N. Cohen and G.J. Armelagos (eds) 1984: 367-392.

MARTIN, R. and K. SALLER. 1957. *Lehrbuch der Anthropologie*. Stuttgart: Fischer.

MASALI, M., B. CHIARELLI et al. 1966. Richerche sulle Collezioni Antropologiche Egiziane Dell'Istituto di Antropologia di Torino. III. (a), Dati Antropometrici: Statura, Robustezza Scheletrica e Proporzioni Intermembrali negli Adulti. *Rivista di Antropologia* 53: 77-94.

MEIKLEJOHN, C., C. SCHENTAG et al. 1984. Socioeconomic Change and Patterns of Pathology and Variation in the Mesolithic and Neolithic of Western Europe: Some Suggestions. In: M.N. Cohen and G.J. Armelagos (eds) 1984: 75-100.

MESKELL, L.M. 1997. *Egyptian Social Dynamics: The Evidence of Age, Sex and Class in Domestic and Mortuary Contexts*. Unpublished PhD Thesis: University of Cambridge.

PÄÄBO, S. and A. DI RIENZO. 1993. A Molecular Approach to the Study of Egyptian History. In: W.V. Davies and R. Walker (eds), *Biological Anthropology and the Study of Ancient Egypt*: 86-90. London: British Museum Press.

RICHARDS, J.E. 1997. Ancient Egyptian Mortuary Practice and the Study of Socioeconomic Differentiation. In: J. Lustig (ed.), *Anthropology and Egyptology: A Developing Dialogue*: 33-42. Sheffield: Sheffield Academic Press.

ROBINS, G. 1983. Natural and Canonical Proportions in Ancient Egyptians. *Göttinger Miszellen* 61: 17-25.

ROBINS, G. and C.C.D. SHUTE. 1983. The Physical Proportions and Living Stature of New Kingdom Pharaohs. *Journal of Human Evolution* 12: 455-465.

.... 1984. Estimating Living Stature from Female Skeletal Remains. *Göttinger Miszellen* 83: 71-76.

.... 1986. Predynastic Egyptian Stature and Physical Proportions. *Human Evolution* 1(4): 313-324.

SCHOENINGER, M.J. 1979. Diet and status at Chalcatzingo: some empirical and technical aspects of strontium analysis. *American Journal of Physical Anthropology* 51(3): 295-310.

SMITH, P. 2002. The Palaeo-Biological Evidence for Admixture between Populations in the Southern Levant and Egypt in the Fourth to Third Millennia BCE. In: E.C.M. van den Brink and T.E. Levy (eds), *Egypt and the Levant: Interrelations from the 4th Through the Early 3rd Millennium BCE*: 118-128. London: Leicester University Press.

SOKAL, R.R. and F.J. ROHLF. 1995. *Biometry*. New York: W. H. Freeman.

STEEGMANN, A.T., Jr. and P.A. HASELEY. 1988. Stature variation in the British American Colonies: French and Indian War records, 1755-1763. *American Journal of Physical Anthropology* 75(3): 413-21.

STOESSIGER, B.N. 1927. A Study of the Badarian Crania Recently Excavated by the British School of Archaeology in Egypt. *Biometrika* 19: 110-150.

STROUHAL, E. 1971. Evidence of the Early Penetration of Negroes into Prehistoric Egypt. *Journal of African History* 12(1): 1-9.

TRIGGER, B.G. 1983. The Rise of Egyptian Civilization. In: B. G. Trigger, B. J. Kemp, D. O'Connor and A.B. Lloyd (eds), *Ancient Egypt: A Social History*: 1-70. Cambridge: Cambridge University Press.

VOLANTE, M.A. 1974. Dati per la Statura dei Metodi di Calcolo della Statura negli Egiziani Antichi. *Archivio per l'Antropologia e la Ethnologia* 104: 361-366.

WHITE, C.D., P.F. HEALY et al. 1993. Intensive Agriculture, Social Status and Maya Diet at Pacbitun, Belize. *Journal of Anthropological Research* 49: 347-375.

WOOD, J.W., G.R. MILNER et al. 1992. The Osteological Paradox: Problems of Inferring Health from Skeletal Samples. *Current Anthropology* 33(4): 343-370.

ZAKRZEWSKI, S.R. 2003. Variation in Ancient Egyptian Stature and Body Proportions. *American Journal of Physical Anthropology* 121(3): 219-229.