ACTA UNIVERSITATIS SZEGEDIENSIS

ACTA BIOLOGICA

NOVA SERIES

TOMUS XLII FASCICULI 1-4

SZEGED (HUNGARIA)
1997

edit
Facultas Scientiarum Naturalium Universitatis Szegediensis de Attila József nominatae

Nota
Acta Biol. Szeged.

Kiadja
a Szegedi József Attila Tudományegyetem Természettudományi Kara
(Szeged, Aradi vértanúk tere 1.)

ISSN 0324-6523
ISSN 0563-0592

Kiadványunk rövidítése
Acta Biol. Szeged.

SPECIAL VOLUME PUBLISHED IN HONOUR OF THE 65TH ANNIVERSARY OF PROF. DR. HABIL. GYULA L. FARKAS

This volume contains studies presented at the Scientific Meeting "ANTHROPOLOGY OF PAST AND PRESENT POPULATIONS", held in Szeged on 21-22 March 1997, on the occasion of the 65th birthday of Professor GYULA FARKAS. The meeting was organized by ANTÓNIA MARCSIK, GYÖRGY PÁLFI, CHARLES SUSANNE and OLIVIER DUTOUR, with the participation of the Department of Anthropology, József Attila University, Szeged; the Móra Ferenc Museum, Szeged; the Committee of Anthropology and Archaeology of the Szeged Board of the Hungarian Academy of Sciences; and under the auspices of the European Anthropological Association.

ACTA BIOL. SZEGED. 42, pp. 5-6 (1997)

FOREWORD

The international colloquium on the "Anthropology of Past and Present Populations" that was held in Szeged on 21-22 March 1997 under the auspices of the European Anthropological Association was an important event allowing an overview of anthropological research in its most current aspects. It was an event that honoured the output (both in quantity and in quality) of research from Hungarian anthropology, and from the head of the Department of Anthropology at József Attila University in Szeged, Professor L. GYULA FARKAS.

This colloquium was primarily organized through the efforts of his colleagues in Szeged, among them ANTÓNIA MARCSIK, GYÖRGY PÁLFI, ZSUZSANNA JUST and ERIKA MOLNÁR, but also of OLIVIER DUTOUR and CHARLES SUSANNE on behalf of the European Anthropological Association, in honour of Professor GYULA FARKAS 65 years of age on 11 April 1997.

Professor GYULA FARKAS merits all our gratitude for his contributions to anthropological sciences, especially as concerns European anthropology, and in particular for the way in which he has built up the reputation of his department in Szeged.

Born in Szabadszállás in 1932, he studied biology at József Attila University in Szeged, where he was awarded his diploma as a biology and chemistry teacher in 1954. His career in fact started with teaching in a grammar school, in Kecskemét, but from 1955, he joined József Attila University in Szeged, first as an assistant, from 1961 as an assistant professor, from 1977 as associate professor, and from 1988 as full professor. Since 1980, he has been head of the Department of Anthropology at József Attila University in Szeged.

On the way to his becoming professor, following his graduation he was awarded three different degrees:

- in 1960: a university doctorate with a thesis on "New data on the physical development of 3999 pupils between 6 and 18 years of age";
- in 1976: a candidate's degree with a thesis on "The paleoanthropology and prehistory of South Hungary";
- in 1987: an academic doctorate with a thesis on "The physical development of children between 10 and 18 years of age and the age at menarche in South Hungary".

Professor GYULA FARKAS is well known for his research activities, for his role as head of the Department of Anthropology of József Attila University in Szeged, and also for his activities on behalf of Hungarian anthropology. From 1970 to 1980 he was secretary, and from 1980 to 1985 president of the Anthropological Committee of the Hungarian Academy of Sciences.

Since 1985, Professor GYULA FARKAS has also been

- a member of the Anthropological Committee of the Hungarian Academy of Sciences;
- a member of the National Postgraduate Degree Granting Board in Biology of the Hungarian Academy of Sciences;
- editor of Acta Biologica Szegediensis;

and since 1991
- president of the Section of the Biological Association in Szeged.

His research topics are of interest for virtually everyone because he has published on such subjects as historical anthropology, growth, development and maturity, and the history of Hungarian anthropology. In total, Professor GYULA FARKAS has published about 230 scientific papers and 50 papers aimed at promoting science.

In honour of Professor GYULA FARKAS, the activities of his team, and the scientific niveau of the biological sciences in general at József Attila University in Szeged, it is hoped that, within the Socrates programmes of the European Union, the Department of Anthropology at József Attila University in Szeged will join the network of universities dedicating their teaching activities towards the award of the European Master degree and a European Ph.D. in Anthropology and Human Biology, through teaching and research of quality at a European level. This EU programme has been restricted so far to the EU countries: Szeged would be the first to join from outside the EU, but it is hoped that other Hungarian and Central-Eastern European departments will follow.

Professor CHARLES SUSANNE
President of the European Anthropological Asssociation
Head of the Laboratory of Anthropogenetics and Ecotechniques,
Vrije University in Brussels, Pleinlaan 2, 1050 Brussels, Belgium

ACTA BIOL. SZEGED. 42, pp. 7-9 (1997)

PROFESSOR DR. HABIL. GYULA L. FARKAS IS 65 YEARS OLD

Curriculum and Congratulations

Dear Reader. The present commemoration only seemingly belongs among the easier genres of writing, even though it is about a friend and colleague whose work and results may be recounted only with great difficulty due to such an abundant career.

The difficulty begins when the commemoration is to be made with humility towards science, with due respect, with truth and with appropriate perspective. This constrains me to moderation. I would like not only to list the merits of GYULA L. FARKAS, but also to recall a short period of the profession, placing the person into the environment.

It is an honour for me to do this between the walls of our Alma Mater, in the columns of its periodical.

GYULA L. FARKAS was born in Szabadszállás, on the Great Hungarian Plain, on 11 April 1932. After finishing his elementary and secondary school education in Kecskemét, between 1950 and 1954 he was a student at the University of Szeged. Those years are mentioned by many today as difficult, gloomy and dark, but it was the period of our youth and it was perhaps our fortune in a sense that we were taught and educated by the great humanist scientists of that age and they were models for us. It was LAJOS BARTUCZ among them who discovered in GYULA L. FARKAS a highly needed new young colleague. He was already a demonstrator in 1953 in the Department of Anthropology and, after a short period of teaching in an elementary school, he was invited and appointed a professor's assistant in 1955.

From this point on, his educational academic career rose rapidly. In 1960 he was first assistant, and 1976 he became a candidate of biological science. In 1977 he was appointed university lecturer, and then in 1980 head of department. In 1985 he was awarded his doctorate of biological science, and in 1988 he became a university professor as head of department.

Between 1970 and 1980 he was Secretary of the Anthropological Committee of the Hungarian Academy of Sciences, while in the cycle 1980-85 he was its president, and he has remained a member since 1985. Since 1980 he has been chief editor of Acta Biologica Szegediensis. Since 1990 he has been president of the Szeged Board of the Hungarian Biological Association. This is a very nice picture, but let us place this career into a picture of the times.

In the evolution of Hungarian biology, the 1960s and 1970s meant the great acme, the bloom. This was the same in Szeged. The show-piece of biology, the Biological Centre of the Hungarian Academy of Sciences, was built in Szeged and some biology departments of the university were given a new, modern building. But there were not only winners, but also losers in the fight for development. Artificially created ideologies clashed. A battle was going on within science between the internationality-nationality of the branches, the experimental-descriptive, the molecular-individual and the submolecular-supraindividual views and for the establishment of priorities. There were casualties of this struggle for life. Such was our small profession.

In spite of its international-quality representatives and researchers, the profession was set back, on the grounds that it did not have the „critical mass" needed for its development. The procedure was not conducted according to that script in Szeged, though.

Scientists can be typified in various ways. One species is the „*homo apoliticus*", who can be found only in scientific conferences and in the warm „niche" of laboratories. The other species is the „*homo politicus*". This latter also has subspecies. One type is self-serving and self-gratifying. The other type, fortunately, is not so rare, and can sometimes be discovered: the scientist who uses politics, scientific and educational public work for the good of his profession.

I put GYULA L. FARKAS into the last category: his public service and activities have served the present and future of the department.

He has been a member of many permanent and ad hoc committees of the university. He has been a member of the Educational Board of the Faculty of Sciences, and of the professional supervising committee of the department. He has been responsible for foreign students in the faculty and a member of the disciplinary committee for students, while involved as a lay member of the county court for cases involving young people. For several years he was secretary of the Expert Biologists Committee of JATE Faculty of Sciences. And last, he ran the basketball section of SZEOL for years.

He did not step on anybody on his way, and when he was shot at, he was not protected by an armour of medals. However, he protected, sheltered and developed his department as a junior assistant and then first assistant, against powerful professors and scientists.

He could do this because beyond all these he taught special courses, led seminars end examined students. He taught special courses for archaeologists, ethnographers and college students of biology.

He has directed the diploma work of 77 students and the studies of 12 doctoral and 2 Ph.D. students. He has been a member of entrance and final state examination boards.

He has been opponent of numerous academic doctoral and candidate dissertations, and president, secretary and a member of juries. For 10 years he has been a member of an Expert Committee of the National Postgraduate Degree Granting Board of the Hungarian Academy of Sciences. During this time, 18 people have earned academic degrees in or close to the profession. That is more than 3 times the number in the cycle before him. He has been not a bad spirit, but a good shepherd of the academic leading body of the profession.

He is currently a member of the Habilitation Board of the Biological Expert Committee at JATE.

The number of his scientific publications exceeds 200 (an exact list of his earlier publications is to be found in „Bibliography of GYULA FARKAS 1953-93", JATE Press, Szeged, 1994, pp. 37).

He is not fond of traveling, but wherever he has been, he took good news of his country, town and university. He has given 37 lectures abroad. The spiritual and material treasures of the department, summarized in an exhibition, are gladly visited by foreign researchers and students of local schools. The anthropological findings of the department from historical ages is acknowledged throughout Europe. This reputation was founded on the cooperation of LAJOS BARTUCZ and FERENC MÓRA. These treasures have not only been preserved by GYULA L. FARKAS, but also developed through friendship with OTTÓ TROGMAYER.

I appreciate it that GYULA L. FARKAS has let himself be influenced by the examined environment, since he has taken part in much field work and has himself collected the data of live investigations. His scientific interests have followed the traditions of the department. The examination of the population living in the Carpathian Basin in historical ages and the biological features of the present-day Hungarians were assigned by LAJOS BARTUCZ as compulsory tasks for every Hungarian anthropologist. His third main research field involves the physical and biological changes in children and youths in relation to time. This research direction was fueled by recent times and the factors influencing the changes.

He is also a worthy follower of great predecessors in disseminating the results of science to the public in a good quality, but in an easily intelligible manner, as proven by his 127 lectures in the country.

Besides nurturing tradition, he has always followed fashion, but always fashion filled with content. Interdisciplinarity = cooperation with archaeologists and ethnographers. International cooperation = discovery and processing of an early Bronze Age cemetery in Mokrin, or the cooperation with foreign colleagues. Methodological reform = an attempt to organize the bone chemistry laboratory in the department.

With foresight, he knows that only those can expect respect and honour in the future, who have given these to the past. His works of science history belong here.

In these days of total computerization, he has performed a great service with his bibliographical activity. By collecting and publishing the scientific results of Hungarian anthropologists, he has made the spectrum of our profession known in wide circles both at home and abroad, and he has provided useful help for students preparing their diploma work.

Dear Reader. After this listing of some of the facts, please allow me a modicum philosophical relaxation.

Time is advancing. The occasions and happenings are the consequences of the changes in society. The connections to one particular person and personality cannot be ruled out. I place the personality for every happening in the Department of Anthropology of JATE during the last 40 years, with consideration to both time and social factors, on GYULA L. FARKAS. To paraphrase a modern slogan, we may say that all this could not have come true without the support of workers, students and colleagues. But they were also selected by him!

Dear GYULA! Finally, I sincerely wish that your eventual successor at the Department of Anthropology of JATE will have such a friend who, in due time, will remember him with warm words and that he too will be worthy of them.

GY. DEZSŐ
H-1089 Budapest, Rezső tér 8., Hungary

ACTA BIOL. SZEGED. 42, pp. 11-16 (1997)

PALEOODONTOLOGIC STUDY OF PRE-AGRICULTURAL AND AGRICULTURAL POPULATIONS

M. ACQUAVIVA

Laboratoire d'Anthropologie Biologique, Faculté de Médecine de Marseille - UMR 6578 CNRS/Université de la Méditerranée, 13385 Marseille Cedex 5, France

(Received: January 10, 1997)

Introduction

The pathology of the periapical area is poorly documented in the paleopathological literature. However, such lesions nowadays comprise an important area of the dental pathology, in relationships with the diet, the dental wear, occlusal trauma and other direct trauma. Inflammation of the dental pulp, initially reversible, will lead, if untreated, to necrosis of the pulp. In most cases, this necrosis will subsequently give rise to a periapical lesion (more commonly known as an abscess), which can be detected macroscopically or radiologically, and which in consequence which can be observed on ancient human remains. In order to establish the frequency of periapical lesions and the etiological agents in the past, and also the variation during evolution, we studied these parameters in two ancient populations, dating from the Early and Middle Holocene, who exhibited an important difference in their diets, one living before and the other one after the beginning of agriculture. The first population is an African preagricultural series from Northern Mali: it belongs culturally in the Epipaleolithic or Mesolithic culture, but also characterized as "Early Neolithic"; their diet was that of hunter-gatherers, similar to the one in Paleolithic times. The other population is from a European agricultural Neolithic series belonging in the Seine-Oise-Marne civilization. This comparative study includes an exhaustive inventory of the series and a study of the pathologies to demonstrate the disparities which may exist in regard of periapical lesions between the European and African Neolithic populations.

The aim of this study was to compare the occurrences of periapical lesions in these two populations on the basis of direct observations on the maxilla and mandible, and by using periapical radiography. The bucco-dental state observed in currently living people provided the state of reference. From an etiological perspective, pulpal inflammation may have various origins, including tooth decay, dental wear, occlusal trauma and dental treatment.

Tooth decay is a chronic bacterial disease which destroys the hard tissues of the teeth. It involves demineralization of the dental tissues by organic acids arising from the fermentation of carbohydrates on the action of bacteria. According to KEYES (NITLICH, 1979), it is a result of 3 factors: diet, heredity and hygiene, which explains why decay is most commonly found in retention areas.

Several authors (BANG, 1989; BROTHWELL, 1989; DREIER, 1994) state dental wear depends on the diet (tough meat, badly cut, badly cooked, plant fibres, etc.), the bite of each person, the muscular strength exerted on the dentition, the masticatory habits, and the quality of the teeth. There are several methods for the study of dental wear: the earliest seems to be that of BROCA (1879), but we decided to use the method of MILES (1963), which is more accurate. We did not take into account the aspect of age in determinations with this method.

Occlusal trauma is generally caused by dental malposition. Such malposition may be caused by dental loss, which leads to the version of adjacent teeth, the shifting of antagonist teeth, and also dento-maxillar dysharmony (a poor relation between the size of the teeth and the size of the maxilla). Direct shocks may reach the pulp and lead to necrosis.

Periapical lesions are visible radiologically if the internal or external bone palate is attacked, or if there is a great destruction of medullary bone. Periapical lesions show up as round and regular radiololucencies. They can lead to pathological root destruction (rhizalysis) and/or or resorption of the alveolar bone. The regular shape of the lesion allows establishment of a differential diagnosis (PASLER, 1987). Many periapical lesions are nowadays found during systematic examination, before the patient experiences any pain. The periapical lesions described today may have either the same etiology as previously or an iatrogenic etiology, caused by poor endondontic treatment, cavity formation in vital teeth, or the effects of prosthetics on vital teeth.

Material and methods

Two series were studied: the Hassi-el-Abiod (Malian Sahara) sample consisted of 92 individuals belonging to an early Holocene population of hunter-gatherers whose diet comprised mainly fish, meat and graminae. In our inventory, we included only the individuals with maxilla, mandible or teeth. Because of their very advanced mineralization, it was impossible to date the human remains directly, but the fauna allowed dating of the bones to 6970 ± 130 BP and 8450 ± 60 BP (DUTOUR and PETIT-MAIRE, 1983). The age distribution was as follows: 76 adults (6 women and 10 men) and 16 children.The 76 adults yielded 37 isolated mandibles, 8 isolated maxillae, and 31 associated mandibles and maxillae. The 16 children provided 6 isolated mandibles, 1 isolated maxilla and 9 associated mandibles and maxillae. During this inventory, we encountered two problems: (i) due to several movings, 5 individuals described previously by DUTOUR (1986) were missing; (ii) as several small pieces were found in the digs AR7 and MK37, we decided to consider each piece as a separate individual, which explains why we total more than the 89 individuals listed in the previous studies.

As concerns the Loisy-en-Brie sample, the previous studies showed the number of people involved to be around 140 (DUTOUR, 1994). We have again made an exhaustive inventory of the maxillae and mandibles kept in the laboratory. Unfortunately, we could not examine the isolated teeth of the series, and some trephined skulls are missing. It has also been necessary to match again mandibles and maxillae because the previous inventory had been lost; further, the numbers on the bones were not matched and there was no posibility to relate cranial/postcranial due to the burial customs.This sample was dated by the 14C method, which gave 3690 ± 100 BP. The population was an agricultural one, whose diet mainly consisted of cereals and other plants. According to our inventory, this population numberd 149 individuals: 116 adults and 33 children. The 116 adults gave 77 isolated mandibles, 13 isolated maxillae and 26 associated mandibles and maxillae. The 33 children afforded 21 isolated mandibles, 13 isolated maxillae and 7 associated mandibles and maxillae.

General data

Age and sex determination: in order to homogenize the population and to obtain more consistent results, children were not included in the study. Only one subject exhibited enamel decay and none of them had periapical lesions. The dividing line between children and adults was taken as the evolution of the second molars (BRABANT and TWIESSELMANN, 1964): if the second molar roots could not be detected radiologically, the subject was regarded as a child (NOSSINTCHOUK, 1991). As regards the adults, in previous studies (DUTOUR, 1986, 1994), the individuals in these series were classified in three categories (young, mature and senile), using classical methods. As we did for the age, we used the previous data for sex determination; some problems arose as concerns the poor preservation for the African series and the dissociation cranial / postcranial remains for the European series.

Dental study

For each series, we made an exhaustive inventory on the basis of analysis of dental morphology (ROMEROWSKI and BRESSON, 1994; TAVERNIER, 1994).Two different methods were used to study the dental pathologies. The first was gross examination, focussed in particular on the periapical lesions mostly revealed by perforation of the internal or external bone plate, on dental decay and on dental wear, quantified via the Miles classification. The second part of this study comprised a systematic radiological examination of all maxillae and mandibles analysed macroscopically.

Results

In connection with the state of preservation of the two series, we established that it was different, to the disadvantage of the Saharan sample (32.7% Hassi-el-Abiod vs. 47% Loisy-en-Brie). This difference seems mainly due to the burial mode (cave protection for Loisy-en-Brie, whereas Hassi-el-Abiod was exposed to various taphonomic agents, such as wind erosion and thermal shock in a desert environment).

As concerns the determination of the age at death of the adults, categorized as young, mature or senile, the success of the determination differed in the two series. More young adults were found in the European series, whereas a rather more "normal" curve for the age distribution was observed for the Saharan material. This repartition in the European series may be caused by a special funeral rite if it could not interpreted as a life span in these European Neolithic series (MASSET, 1986). As regards the sex distribution, in the Hassi-el-Abiod series we could only determine the sex of 16 out of the 76 individuals in the sample, i.e. a determination rate of 21%. The distribution was 6 women and 10 men, which shows an unequal sex ratio, with a male prevalence of about 25%. However, this result may be explained by the small number of individuals studied, the diagnostic methods used (based only on coxal bones) and the very high percentage of undeterminate individuals, linked to preservation problems; this prevents the drawing of general conclusions. In Loisy-en-Brie, we determined the sex of 92 of the 116 individuals, i.e. a determination rate of 80%. The distribution was 40 women and 52 men, which shows a quite balanced sex ratio.

The odontological sites (O.S.) studied were:

- the dental odontological sites (D.O.S.) = whole teeth in their proper place;

- the radicular odontological sites (R.O.S) =crown missing, roots in their proper place;

- the alveolar odontological sites (A.O.S) = teeth missing, sockets kept.

As concerns the preservation of the O.S. for the maxilla, the D.O.S. were comparable in both series, but there was a reversal between the R.O.S and A.O.S percentages. For the mandible, the same was true for the A.O.S and R.O.S, but the preservation of the D.O.S. was very different, with a preference for Loisy-en-Brie (36.4% vr. 16.2% for Hassi-el-Abiod); this could not be considered a bias, because it was presumed that the ante-mortem losses were caused by taphonomics problems and not by pre-existing pathologies, periapical or not.

As to the frequency of periapical lesions, we obtained the same result in the two series (0.96 in Loisy-en-Brie, and 0.96 in Hassi-el-Abiod).

When this result was compared with the totality of the dental pathologies observed in these series, the frequency of dental decay was found to be 6 times higher in Loisy-en-Brie than that in Hassi-el-Abiod. This can be linked with the difference in diet: a pre-agricultural series with a diet consisting mainly of meat, followed by an agricultural series with a diet of cereals and plants (KNYCHALSKA-KARWAN et al., 1972). On the other hand, the dental wear of those population does not reveal a significant difference, though wear occurred earlier in Loisy-en-Brie than in Hassi-el-Abiod. Two hypotheses might explain this difference: the first one is based on the effect of oclusion, leading to a different masticatory strength. This interpretation can be correlated with the fact that the Saharan series displays an archaic occlusion (MAYTIE, 1976), classified as "end-to-end occlusion" or class III in Angle's classification, whilst the European Neolithic series presents an occlusion similar to ours (class I of ANGLE, BENAUWT and LORETTE, 1882). The second interpretation is a reduced enamel toughness at Loisy-en-Brie, due to genetic differences in enamel robusticity between the two series.

The ante-mortem loss occurred 3 times more often in Loisy-en-Brie than in Hassi-el-Abiod (7.1% vs. 2.4%.) This ante-mortem loss can be linked with the higher frequency of caries found in Loisy-en-Brie.

However, it is difficult to link it with periapical lesions: even with 6 times more caries in Loisy-en-Brie, the frequency of periapical lesion is roughly the same in the two series. By comparison, about 70% of the current population have missing teeth (SAILLY et al., 1995).

A comparison of these series with present populations reveals the following differences :

- an improvement in bucco-dental hygiene in comparison with the Neolithic period;

- a significant increase in the frequency of decay (the third cause of morbidity according to the OMS); this is caused by a change in diet and mainly by the introduction of refined sugar;

- a decrease in dental wear, which can also be linked with the change in diet; nowadays dental wear similar to that found in Neolithic times is very seldom (GAMBAROTTA, 1995);

- a decrease in ante-mortem loss due to dental decay, but an increase of those related to parodontal problems.

Conclusions

Overall, this study revealed that:

- the frequency of dental decay is much more greater today than in prehistoric times, even in agricultural populations;
- the frequency of missing teeth is higher nowadays;
- periapical lesions also seems more frequent today in relationship with dental decay, dental trauma, etc.;
- only dental wear has decreased, but this wear has little influence on periapical problems and ante-mortem loss.

The results demonstrate the pernicious effects of modern life on the dental system of *Homo sapiens* in comparison with the more natural way of life in prehistoric times, whatever the type of the diet (hunter-gatherers or pastoralists) and in spite of the then lack of dental hygiene and care.

References

BANG, G., (1989): Age Changes in Teeth: Developmental and Regressive. In: ISCAN, M. Y. (ed.): Age Markers in the Human Skeleton. - C. C. Thomas, Spingfield, Illinois, 211-235 pp.

BENAUWT, A. and LORETTE, A. (1982): Manuel d'Orthodontie pour Omnipraticiens. - SNPMD, Paris, 136 p.

BRABANT, H. and TWIESSELMANN, F. (1964): Observations sur l'Evolution de la Denture Humaine en Europe Occidentale. - Bulletin du Groupement International pour la Recherche Scientifique en Stomatologie *1*, 63-72.

BROCA, P. (1879): Instructions Relatives à l'Etude de l'Anthropologie du Système Dentaire. - Bulletins de la Société d'Anthropologie de Paris, 126-165.

BROTHWELL, D. R. (1989): The Relationship of Tooth Wear to Aging. In: ISCAN, M. Y. (ed.): Age Markers in the Human Skeleton. - C. C. Thomas, Spingfield, Illinois, 303-316 pp.

DREIER, F. G. (1994): Age at Death Estimates for the Protohistoric Arikara Using Molar Attrition Rates: A New Quantification Method. - International Journal of Osteoarchaeology *4*, 137-147.

DUTOUR, O. (1986): Anthropologie Ecologique des Populations Néolithiques du Bassin de Taoudenni (Mali). - Doctorat ès Sciences de l'Université d'Aix-Marseille II.

DUTOUR, O. (1994):L'Hypogée Néolithique de Loisy-en-Brie (Marne), Lieu-dit les Gouttes d'Or. Données Paléoanthropologiques générales. - Revue d'Etudes Préhistoriques et Protohistoriques de Champagne-Ardenne *18*, Montmirail, 63-64.

DUTOUR, O. and PETIT-MAIRE, N. (1983): Sépultures et Restes Osseux. In: PETIT-MAIRE, N. and RISER, J. (eds): Sahara ou Sahel? Le Quaternaire Récent du Bassin de Taoudenni (Mali). - Marseille-Lamy, Marseille, 277-316 pp.

GAMBAROTTA, J. P. (1995): Usure Dentaire Macroscopique de Quelques Echantillons de Populations du Nord du Maroc (Préhistoriques et Actuelles). - Bulletins et Mémoires de la Société d'Anthropologie de Paris *7*(1-2), 21-36.

KNYCHALSKA-KARWAN, Z., LASKOWSKA, L., PELCOWA, M., SZAFRANIEC, I. and WELDER, A. (1972): Carie et Abrasion Dentaire. - Rev. Odontostomatol. Paris *19* (6), 471-474.

MASSET, C. (1986): Estimateurs Paléodémographiques. In: FEREMBACH, D., SUSANNE, C. and CHAMLA, M. C. (eds.): L'Homme, son Evolution, sa Diversité. Manuel d'Anthropologie Physique. - Editions du CNRS, Paris, 65-69 pp.

MAYTIE, A. (1976): Usure et Articulé Dentaire en Anthropologie. - Actual. Odontostomatol. Paris *113*, 147-165.

MILES, A. E. W. (1963): Dentition in the Estimation of Age. - J. Dental Res. *42*, 255-263.

NITLICH, J. and ZEILIG, G. (1979): Abrégé de Dentisterie Conservatrice, 1 : Les Tissus Durs. - Masson, Paris, 141 p.

NOSSINTCHOUK, R. M. (1991): Manuel d'Odontologie Médico-Légale. - Masson, Paris, 214 p.

PASLER, F. A. (1987): Manuel de Radiologie Dentaire et Maxillo-Faciale. - Doin Editeurs, Paris, 374 p.

ROMEROWSKI, J. and BRESSON, G. (1994): Morphologie Dentaire de l'Adulte. - Encycl. Med. Chir. (Paris - France), Stomatologie et Odontologie I, 22-033-A-10, 34 p.

SAILLY, J. C., LEBRUN, T. and MENNARAT, F. (1995): Situation de la Santé Dentaire en France. - Etat des Lieux, Orientations Stratégiques, Centre Odontologique de Médicométrie et d'Evaluation (COME), Toulouse.

TAVERNIER, B. (1994): Morphologie Dentaire Temporaire. - Encycl. Med. Chir. (Paris - France), Stomatologie et Odontologie I, 22-003-M-10, 12 p.

ACTA BIOL. SZEGED. 42, pp. 17-24 (1997)

ANTHROPOLOGICAL PRESENTATION OF SKELETONS FROM THE VERUŠIC–NA (VOJVODINA, YUGOSLAVIA) CEMETERY FROM THE SARMATIAN AGE (4TH–5TH CENTURIES)

G. CZÉKUS

College for Kindergarten Teachers, Subotica, Yugoslavia

(Received: December 10, 1996)

Abstract

This paper deals with 56 skeletons discovered in Verušic, which originate from the Sarmatian age (end of the 4th, beginning of the 5th century). A large number of graves were robbed. The number of infant skeletons was small. There were more male than female skeletons. Most of the members of both sexes had died at a mature age (50–60 years old). The skulls of the males were dolichocranic, orthocranic, acrocranic and eurymetopic, while those of the females were mesocranic and metriometopic. The stature of the males was medium tall, whereas that of the females was short.

Key words: Verušić, 4th–5th centuries A.D., morphometric analysis, anatomic variations.

Introduction

In 1979, tombes were found 7 km south of Subotica, on the area of the Verušic farms, near the Subotica-Novi Sad railway-track. The excavation revealed one aligned cemetery, which originated at the end of the 4th, or the beginning of the 5th century. The entire cemetery, consisting of 56 tombs, was opened. An 11th century cemetery was also found at the same site (CZÉKUS, 1994; SZEKERES and SZEKERES, 1996).

Material and methods

Many tombes had been robbed. The bones which could be examined were badly preserved. The determination of age for the children was based on the teeth, according to SCHOUR and MASSLER (1941), whereas for the juveniles it was based on the ossification of the epi- and diaphysis, according to HARSÁNYI (FARKAS et al., 1972). The age of the adults was determined according to NEMESKÉRI et al. (1960). The sex of the adults was determined by the method of ACSÁDI and NEMESKÉRI (1970). The measurements and descriptions were carried out according to MARTIN'S handbook (MARTIN and SALLER, 1957). Stature was calculated according to the formulae of BREITINGER and BACH (FARKAS et al., 1972), PEARSON (RÖSING, 1988) and SJOVOLD (1990).

Results and discussion

Age and sex distribution of the skeletons

There were 51 adult and 5 infant skeletons. Parts of the infant skeletons were missing. The adults included 24 definite males and 18 definite females. Most of them had died at a mature age (Table 1).

Table 1. Age and sex distribution of the skeletons.

Age groups		Infants		Males		Females		Total	
		N	%	N	%	N	%	N	%
Infants I	0-7	3	75.0					3	5.4
Infants II	8-14	1	25.0			1	5.6	2	3.6
Juvenile	15-22			1	4.2	1	5.6	2	3.6
Adult	23-39					1	5.6	1	1.8
Mature	40-59			11	45.8	11	61.1	22	39.3
Senile	60-x			6	25.0			6	10.7
?				6	25.0	4	22.2	20	35.7
Total		4	100.0	24	100.0	18	100.0	56	100.0

Metric characteristics of the skulls

Due to the small number of skulls, the obtained results should be treated with some reserve. The skulls of the males and females differed only in the upper face. It was medium long and narrow; the forehead was medium broad (dolichocranic and mesocranic; orthocranic and hypsicranic; acrocranic and eurymetopic and metriometopic). Measurements of the face were possible only in certain cases (Tables 2-4).

Morphological characteristics of the skulls

Viewed from above, the skulls of the males were ellipsoid and sphenoid, while those of the females were ellipsoid. From the rear view, they were house-shaped. The glabellae of the males were of 4th degree, while those of the females were of 2nd degree. The fossa canina was moderate. Moderate prognathia alveolaris was characteristic (Table 5).

Characteristics of the post-cranial bones

For both sexes, a moderate asymmetry was observed. The male bones were robust. Both sexes were characterized by a symmetrical forearm. A weak pilaster was observed on the thigh-bones of the males, but not on those of the females. For both sexes, the pilaster was platymeric. The tibia was eurycnemic (Table 6). The following anatomic variations were observed: there was no processus supracondyloideus on the left humerus, and trochanter tertius did not occur at all.

Calculated stature

The individual values differed. The values calculated by different methods also differed from one another (Tables 7 and 8). The average stature of the males was medium tall, while that of the females was short. Due to the small number of bones which could be measured, a statistically evaluable comparison was not conducted.

Table 2. Parameters of cranial measurements and indices

	Males				Females			
Martin no.	N	V min-max	mean	s	N	V min-max	mean	s
1.	5	182-201	188.40	6.59	4	175-183	178.75	3.77
1.c	6	180-200	186.00	6.53	4	174-192	182.50	6.38
8.	6	133-145	138.50	5.02	4	132-139	134.75	2.68
9.	6	92-105	98.67	4.07	3	88-98	93.00	4.08
17.	2	133-143	138.00	5.00	1	142	142	
23.	3	511-530	523.00	8.52	1	508	508	
38.	2	1383-1492	1437.54	54.56	1	1356	1356.27	
40.	1	110	110		1	97	97	
43.	1	102	102		1	99	99	
45.	1	131	131					
46.	1	94	94					
47.	1	127	127	1	120	120		
48.	2	62-73	67.50	5.50	1	75	75	
51d	1	43	43					
51s	2	39-41	40.00	1.00	2	38-41	39.50	1.50
52d	1	30	30					
52s	2	30-32	31.00	1.00	2	34-35	34.50	0.50
54.	3	23-28	26.33	2.39	1	25	25	
55.	2	47-51	49.00	2.00	1	52	52	
62.	4	42-49	44.50	2.69	2	36-42	39.00	3.00
63.	3	42-46	43.67	1.61	2	38-42	40.00	2.00
65.	3	111-122	117.00	4.55	1	120	120	
66.	4	96-113	103.75	7.01	3	96-118	104.00	9.93
68.	7	73-82	78.00	2.98	3	76-82	78.67	2.39
69.	7	29-39	34.00	3.30	6	27-32	30.50	1.89
69(1)	9	28-38	32.11	2.78	7	26-32	28.71	2.11
69(2)	8	24-31	26.75	2.17	6	22-25	23.67	1.18
69(3)	10	9-14	11.10	1.70	7	8-11	9.57	1.06
70.	9	60-76	69.33	4.60	6	52-72	62.83	6.82
71.	11	28-37	32.64	2.89	8	26-34	29.75	2.54
8:1	5	71.51-78.38	73.38	2.67	3	74.18-79.43	76.34	2.38
17:1	2	73.08-76.06	74.57	1.51	1	78.02	78.02	
17:8	2	100.00-105.93	102.96	3.06	1	105.19	105.19	
9:8	4	68.75-77.78	72.64	3.44	3	66.67-72.59	68.72	2.79
48:45	1	47.33	47.33					
52:51d	1	69.77	69.77					
52:51s	2	76.92-78.05	77.49		2	85.36-89.47	87.42	2.04
54:55	2	48.93-54.90	51.67	4.74				
63:62	2	87.76-95.45	91.60	3.96	2	100.00-105.56	102.78	2.69
69(3):69(1)	9	29.03-45.16	35.35	4.59	7	26.68-42.31	33.59	5.01

Conclusions

This paper deals with the 56 skeletal remains from the 4th–5th centuries A.D. found at a Sarmatian-age site at Verušic-Na. There were a small number of infant II skeletons, but no infant I ones. There were more males than females among the adults. Most of them had died at the age of 50-60 years. The skulls of the males were dolichocranic, orthocranic, acrocranic and eurymetopic, whereas those of the females were mesocranic and metriometopic. The average stature of the male population was medium tall, while that of the females was short.

Table 3. Distribution of some cranial measurements according to class categories.

Martin no.		Males			Females		
			N	%		N	%
1.	Medium	180-189.9	4	80.00	170-179.9	2	50.00
	Long	190-x	1	20.00	180-x	2	50.00
8.	Narrow	x-139.9	3	50.00	x-134.9	2	50.00
	Medium	140-149.9	3	50.00	135-144.9	2	50.00
9.	Narow	x-96.9	2	33.33	x-92.9	1	33.33
	Medium	97-101.9	2	33.33	93-97.9	1	33.33
	Broad	102-x	2	33.33	98-x	1	33.33
17.	Medium	130-137.9	1	50.00			
	High	138-x	1	50.00	135-x	1	100.00
45.	Medium	130-137.9	1	100.00			
47.	High	122-x	1	100.00	114-x	1	100.00
48.	Low	x-68.9	1	50.00			
	Medium	69-73.9	1	50.00			
	High				70-x	1	100.00

Table 4. Distribution of some cranial indices according to class categories.

Martin no.			Males		Females	
			N	%	N	%
8:1	Dolichocranic	70-74.9	4	80	1	33.3
	Mesocranic	75-79.9	1	20	2	66. 7
17:1	Orthocranic	70-74.9	1	50		
	Hypsicranic	75-x	1	50		
17:8	Akrocranic	98-x	2	100	1	100
9:8	Metriometopic	66-68.9	1	25	2	66.7
	Eurymetopic	69-x	3	75	1	33.3
48:45	Euryen	45-49.9	1	100		
52:51d	Chamaeconch	x-75.9	1	100		
52:51s	Mesoconch	76-84.9	2	100		
	Hypsiconch	85-x			2	100
54:55	Hyperchamaerrhine	58-x	2	100		
63:62	Brachystaphyline	85-87.9	2	100	2	100

Table 5. Morphological characteristics of the skulls

	Males		Females	
Characteristics	N	%	N	%
Norma verticalis				
ellipsoid	1	16.7	2	66.7
pentagonoid	2	33.3		
rhomboid			1	33.3
ovoid	1	16.7		
sphenoid	2	33.3		
Norma occipitalis				
bomb-shaped	2	33.3		
house-shaped	4	66.7	2	100.0
Slope of forehead				
straight	1	14.3	2	50.0
mod.sloped	4	57.1	2	50.0
sloped	2	28.6		
Occiput				
bathrocranic			1	20.0
curvoccipital	1	16.7	1	20.0
mod. curvooccipital	5	83.3	3	60.0
Protuberantia occipitalis externa				
0			3	50.0
1			2	33.3
2	1	12.5		
3	6	75.0	1	16.7
4	1	12.5		
Glabella				
1			1	20.0
2			3	60.0
4	4	57.1	1	20.0
5	2	28.6		
6	1	14.3		
Orbita				
round			2	100.0
ellipsoid	1	33.3		
rectangular	2	66.7		
Apertura piriformis				
infantile	2	50.0	1	50.0
fossa praenasalis			1	50.0
sulcus praenasalis	2	50.0		
Spina nasalis anterior				
2	1	20.0		
3	3	60.0		
4			1	50.
5	1	20.0	1	50.0
Fossa canina				
shallow	1	20.0		
moderate	4	80.0	2	66.7
deep			1	33.3
Prognathia alveolaris				
moderate prognath	4	100.0	1	50.0
prognath			1	50.0

Table 6. Distribution of postcranial indices according to class categories

Martin no.			Males				Females			
			N	$V_{max-min}$	mean	s	N	$V_{max-min}$	mean	s
Clavicula	1	d	4	140-149	144.75	3.27	1	132-132	132.00	
		s	3	148-163	153.67	6.65	2	121-136	128.50	7.50
	6	d	13	35-56	42.62	5.06	5	31-39	34.40	2.80
		s	9	34-49	41.00	4.67	6	29-39	33.00	3.27
Humerus	1	d	5	306-321	314.80	5.84	1	297-297	297.00	
		s	4	294-330	314.75	3.14	2	289-295	292.00	3.00
	2	d	5	306-314	310.20	2.93	1	291-291	291.00	
		s	5	301-327	310.80	8.66	2	283-293	288.00	5.00
	7	d	12	62-72	66.58	2.66	7	50-63	56.00	3.93
		s	10	54-71	64.90	4.30	8	48-59	54.38	3.12
Radius	1	d	3	242-247	244.00	2.16	2	213-215	214.00	1.00
		s	3	240-247	243.00	2.94	1	211-211	211.00	
	1b	d	3	238-244	240.33	2.62	2	212-214	213.00	1.00
		s	3	238-246	240.67	3.77	1	209-209	209.00	
Ulna	1	d	2	262-263	262.50	0.50				
		s	2	262-263	262.50	0.50	1	236-236	236.00	
Femur	1	d	4	425-495	461.25	32.39	4	377-402	392.25	9.28
		s	4	410-444	428.75	12.15	4	397-404	401.50	2.69
	2	d	4	422-495	458.00	33.19	4	369-401	387.50	11.59
		s	4	402-439	424.25	13.63	4	391-402	398.00	4.18
	6	d	18	24-33	28.28	2.84	12	19-28	22.83	2.51
		s	19	23-33	27.63	2.66	12	20-24	22.75	1.30
	7	d	18	24-33	28.00	2.56	12	21-28	23.92	1.93
		s	19	25-32	28.53	2.44	12	21-27	24.00	1.73
	9	d	17	28-38	34.06	2.92	10	25-34	28.80	2.60
		s	19	27-40	33.05	3.62	7	22-35	29.29	3.92
	10	d	17	23-30	26.65	2.11	10	20-27	23.40	2.33
		s	19	23-30	26.16	2.03	7	20-32	24.86	3.64
Tibia	1	d	3	345-353	349.67	3.40	3	307-334	317.67	11.73
		s	3	348-357	351.33	4.03	3	310-336	320.67	11.12
	1b	d	3	343-352	346.00	4.24	3	303-328	314.33	10.34
		s	3	344-352	347.00	3.56	4	300-329	313.75	10.50
	8a	d	15	24-35	31.00	2.83	10	20-31	26.40	2.84
		s	12	27-38	33.00	3.19	10	21-33	27.40	2.91
	9a	d	15	21-29	24.27	2.08	10	17-23	20.10	1.58
		s	12	21-30	24.58	2.36	10	18-23	20.30	1.55
Fibula	1	d	2	344-352	348.00	4.00	1	324-324	324.00	
		s	1	342-342	342.00					
Sacrum	2		3	106-117	112.67	4.78	4	95-121	104.75	10.06
	5		1	116-116	116.00		1	105-105	105.00	
Pubis length		d	2	70-76	73.00	3.00	2	75-78	76.50	1.50
		s	2	65-71	68.00	3.00				
Ischium length		d	1	108-108	108.00	0.00	2	103-108	105.50	2.50
		s	2	111-112	111.50	0.50				
Cotylum breadth		d	9	30-44	38.22	3.91	3	29-33	31.33	1.70
		s	7	38-47	41.00	2.62	4	29-36	32.50	2.50
Inc.isch.breadth		d	6	21-31	24.50	3.25	2	48-50	49.00	1.00
		s	5	24-27	25.80	1.17	4	25-51	39.50	10.23
Clavicula	6:1	d	4	26-40	31.55	5.63	1	27-27	26.52	
		s	3	26-30	28.58	2.05	2	24-25	24.16	0.63
Humerus	7:1	d	5	21-24	21.74	0.96	1	19-19	18.86	
		s	4	20-24	21.44	1.65	2	19-20	19.18	0.54
Femur	6:7	d	18	79-122	101.31	9.08	12	80-114	95.88	11.36
		s	19	81-112	97.08	7.68	12	81-110	95.27	8.59

Table 6. (continued).

Martin no.		Males N	Vmax-min	mean	s	Females N	Vmax-min	mean	s
Femur 10:9	d	17	68-93	78.54	6.24	10	68-108	81.89	11.29
	s	19	66-100	79.89	9.11	7	74-114	85.86	14.11
Tibia 9a:8a	d	15	70-91	78.62	6.6	10	69-85	76.54	5.05
	s	12	66-84	74.73	5.53	10	67-88	74.62	6.93
Rad.1:Hum. 2	d	3	77-79	78.21	0.81	1	73-73	73.2	0
	s	3	79-80	79.33	0.54	1	75-75	74.56	
Pub.:Isch.	d	1	70-70	70.37		2	69-76	72.59	3.15
	s	2	59-63	60.98	2.41				
Cotylo.-Inc.	d	6	97-150	146.71	30.11	2	64-69	66.38	2.38
	s	5	148-167	156.9	7.17	4	63-116	87.95	22.13
Sacrum		1	99-99	99.15		1	87-87	86.78	

d = right s = left

Table 7. Parameters of the stature.

Methods of	Males N	Vmax-min	mean	s	Females N	Vmax-min	mean	s
Breitinger/Bach	9	161.76-175.24	168.26	4.05	5	151.08-158.78	155.93	2.84
Olivier	9	155.78-176.35	165.87	5.75	5	149.35-156.44	153.36	2.48
Pearson	9	156.58-172.50	163.18	4.83	5	145.99-150.65	148.62	1.56
Sjøvold	9	155.62-179.57	167.16	6.98	5	147.99-155.59	153.02	2.75

Table 8. Class categories of the stature.

Class		Breitinger N	%	Pearson N	%	Sjøvold N	%
Males							
Short	150.0-159.9			2	22.22	2	2.22
Med. short	160.0-163.9	1	11.11	5	55.56	1	11.11
Medium	164.0-166.9	2	22.22			4	44.44
Medium tall	167.0-169.9	4	44.44				
Tall	170.0-179.9	2	22.22	2	22.22	2	22.22
Total		11	100.00	9	100.00	9	100.00
Females							
Short	140.0-148.9			3	60.00	2	40.00
Medium short	149.0-152.9	1	20.00	2	40.00	1	20.00
Medium	153.0-155.9	1	20.00			2	40.00
Medium tall	156.0-158.9	3	60.00				
Total		6	100.00	5	100.00	5	100.00

References

ACSÁDI, Gy. and NEMESKÉRI, J. (1970): History of Human Life Span and Mortality. - Akadémiai Kiadó, Budapest.

CZÉKUS, G. (1994): Embertani vizsgálatok Verušic-B. (Vojvodina, Jugoszlávia) XI. századi temetkezéseinek csontvázmaradványain. - Anthrop. Közl. *36*, 21– 38.

FARKAS, GY., LENGYEL, I. and MARCSIK, A. (1972): Anthropológiai Praktikum I. - JATE, Szeged.

MARTIN, R. and SALLER, K. (1957–1966): Lehrbuch der Anthropologie, Bd.1-2.

NEMESKÉRI, J., HARSÁNYI, L. and ACSÁDI, Gy. (1960): Methoden zur Diagnose des Lebensalters von Skelettfunden. - Anthrop. Anz. *24*, 70 – 95.

RÖSING, F.W. (1988): Körperhöhenrekonstruktion aus Skelettmaßen I/1. 586–600 - In: KNUßMANN, R. and MARTIN, R. (eds): Anthropologie. Handbuch der verleichenden Biologie des Menschen. - G. Fischer, Stuttgart–New York.

SCHOUR, J. and MASSLER, M. (1941): The development of the human dentition. - J. Amer. Dent. Assoc. *28*, 1153–1160.

SJØVOLD, T. (1990): Estimation of stature from long bones utilizing the line of organic correlation. - J. Human Evolution *5*, 431–447.

SZEKERES, L. and SZEKERES, Á. (1996): Szarmata és XI. századi temetők Verusicson (Subotica-Azotara). - Szabadka.

ACTA BIOL. SZEGED. 42, pp. 25-29 (1997)

INFANT MORTALITY PATTERNS IN OSTEOARCHEOLOGICAL SAMPLES

K. ÉRY[1], A. MARCSIK[2], CS. SUSKOVICS[3], K. T. RENDES[4] and G.TÓTH[5]

[1]*H-1038 Budapest, Hollós Korvin u. 4.;* [2]*Department of Anthropology, József Attila University, H-6701 Szeged, P.O.Box 660;* [3]*H-7443 Somogyjád, Jókai u. 4.;* [4]*H-8360 Keszthely, Nyárfa u. 31.;* [5]*Berzsenyi Dániel Teachers' Training College, H-9701 Szombathely, Hungary.*

(Received: December 10, 1996)

Abstract

Infant mortality patterns were investigated in 20 osteoarcheological samples from the territory of present-day Hungary and dated to the 3rd-17th centuries. All series contained a lower number of 0-year-olds and a surplus of 5-14-year-olds as compared with the model life tables of COALE and DEMÉNY. Even if the number of 0-year-olds was corrected, the death rate of the 1-4-year age group, and especially that of the 5-14-year age group, did not show the infant mortality rate to be expected from the model life tables. This brings into question either the adoptability of model life tables in paleodemographic studies or the demographic validity of the skeletal material as a mirror of the one-time living community.

Key words: infant mortality, paleodemography, model life table, Hungary, 3rd-17th centuries

Introduction

An undisturbed cemetery used between the middle of the 9th century and the beginning of the 10th century at the Esztergályhorváti-Alsóbárándpuszta site (Western Hungary) was completely uncovered by R. MÜLLER in 1981 (SZŐKE, 1996). Between 1994 and 1996, a complex paleoanthropological analysis was carried out by the authors, including non-metric traits by M. FINNEGAN. The skeletal material of 319 individuals is housed in the Balatoni Museum, Keszthely.

The present paper analyses the age group distribution of the infant skeletons from Esztergályhorváti-Alsóbárándpuszta and of 19 published samples, in comparison with the model life tables of COALE and DEMÉNY (1966).

Results and discussion

Study of the infant mortality rates in 20 series (Table 1) in comparison with the model life tables of COALE and DEMÉNY (1966) (Table 2) revealed two noteworthy phenomena .

Table 1 Infant mortality rates (d_x) at different sites (raw data)

Sites and centuries	Cases	Age groups (years) 0	1-4	5-9	10-14	0-14	15-x
Late Roman Period, 3rd-5th							
Budapest-Kaszásdűlő (FRÁTER, 1993)	335	10.15	5.34	8.54	14.69	38.72	61.28
Keszthely-Dobogó (ACSÁDI and NEMESKÉRI, 1970)	120	4.25	13.67	7.92	2.50	28.34	78.66
Pécs-István tér (ÉRY, 1973)	152	9.21	21.45	7.57	3.22	41.45	58.55
Tokod (ÉRY, 1981)	147	2.72	11.36	6.33	7.48	27.89	72.11
Avar Period, 6th-8th							
Ártánd (ÉRY, 1966, 1967)	258	2.33	7.79	9.03	6.82	25.97	74.03
Bačko Petrovo Selo (ÉRY, 1990)	100	3.00	17.00	12.00	5.00	37.00	63.00
Gyenesdiás (T. RENDES, 1993)	265	8.58	26.12	10.90	4.40	50.00	50.00
Gyöngyöspata-Előmály (GARABÁS, 1993)	209	4.30	13.78	11.29	4.50	33.87	66.13
Kereki-Homokbánya (BERNERT, 1996)	148	0.68	2.09	10.71	4.90	18.38	81.62
Avar-Slavic Period, 9th							
Esztergályhorváti (under elaboration)	319	18.18	24.33	10.66	2.95	56.12	43.88
Garabonc I (ÉRY, 1992)	82	8.54	20.85	4.02	3.17	36.58	63.42
Sopronkőhida (ACSÁDI and NEMESKÉRI, 1970)	145	14.66	17.88	11.40	2.28	46.22	53.78
Zalaszabar-Dezsősziget (ÉRY, 1992)	83	18.07	29.40	10.60	3.37	61.44	38.56
Early Middle Age, 10th-11th							
Püspökladány I. (HÜSE et al., 1996)	230	1.74	14.57	15.61	5.73	37.65	62.35
Püspökladány II. (HÜSE et al., 1996)	371	2.61	13.61	13.01	6.85	36.08	63.92
Sárbogárd (ÉRY, 1967-68)	100	3.00	8.00	15.70	7.30	34.00	66.00
Late Middle Age, 13th-17th							
Alsórajk-Kastélydomb (MENDE, 1996)	375	1.60	8.80	11.27	6.96	28.63	71.37
Dombóvár-Békató (ÉRY, 1979-80)	255	6.28	12.90	11,02	8.63	38.83	61.17
Fonyód-Vár (NEMESKÉRI and NOZDROVICZKY, 1963)	167	0.00	9.58	13.17	6.59	29.34	70.66
Nagytálya (K. KOROMPAI, 1974)	150	2.00	4.60	8.27	6.73	21.60	78.44
Mean		6.10	14.16	10.45	5.54	36.40	63.60

Table 2. Infant mortality rates in model life tables of COALE and DEMÉNY

Families and levels		e_x^0	Age groups (years)					
			0	1-4	5-9	10-14	0-14	15-x
East	4	26.2	36.32	11.88	2.80	1.38	52.38	47.62
West	4	26.4	30.08	13.66	3.00	2.14	48.88	51.12
North	4	26.1	26.46	16.80	5.47	2.56	51.29	48.71
South	4	27.3	25.74	19.97	3.46	1.67	50.84	49.16
		Mean:	29.65	15.58	3.68	1.94	50.85	49.15
East	5	28.7	33.42	11.31	2.73	1.36	48.82	51.18
West	5	28.8	27.56	12.85	2.90	2.07	45.38	54.62
North	5	28.6	24.25	15.75	5.27	2.49	47.76	52.24
South	5	29.7	23.97	18.60	3.32	1.62	47.51	52.49
		Mean:	27.30	14.63	3.56	1.88	47.37	52.63
East	6	31.2	30.73	10.69	2.64	1.85	45.91	54.09
West	6	31.3	25.25	12.02	2.78	2.57	42.62	54.38
North	6	31.0	21.21	14.70	5.04	2.44	43.39	56.61
South	6	32.1	22.35	17.27	3.15	2.17	44.94	55.06
		Mean:	21.89	13.67	3.40	2.26	44.22	55.78

The number of 0-year-old infants is less and the number of 5-14-year-old infants is higher than expected at levels 4, 5 and 6 on the basis of the model life tables.

This points clearly to the fact (often presumed) that a large number of infants were usually not buried in the community cemetery, or their graves were possibly destroyed due to erosion of the ground surface or other external forces during the centuries. The artificial loss of infants changed the life expectancy calculations not only at 0 years of age but in other age groups too. To eliminate this problem, correction of the number of infant deaths according to some mortality model has become a widely accepted practice. The model of COALE and DEMÉNY (1966) has been used in our work as usual, but we do not have any clear reference points as to what "family" and what level distribution should be used in the case of our paleoanthropological series (Table 2). Traditionally, level 5 is usually accepted, since, according to the ACSÁDI and NEMESKÉRI (1970) estimate, the average life expectancy at birth in the 10th-12th century population of Hungary was 28 to 29 years. What "family" (north, east, south or west in the COALE and DEMÉNY tables) mortality model should be used in our case (compared with the skeletal data) is completely unclear.

If we correct the number in 0-year-olds in the 20 series under investigation, for purely experimental purposes, and take the mean values of the 4 "families" (north, east, west and south) at level 5 as the basis of calculations, the age distribution of our samples is as shown in Table 3.

The percentages for the 1-4, 5-9 and 10-14-year age groups decrease relative to the original data due to the increase in the number of 0-year-olds, but even so they do not display the values to be expected on the basis of the model life tables. In the majority of the cases, there is a lower rate in the 1-4-year age group and a higher rate in the 5-14-year age group.

This seems to indicate that the hiatus that can be observed for 0-year-olds in all of the samples under investigation is also partly true for the 1-4-year age group.

Table 3. Infant mortality rates (d_x) at different sites (corrected data).

Sites and centuries	Age groups (years)					
	0	1-4	5-9	10-14	0-14	15-x
Late Roman Period, 3rd-5th						
Budapest-Kaszásdűlő	30.48	4.00	6.38	11.00	51.86	48.14
Keszthely-Dobogó	29.57	10.06	5.83	1.84	47.30	53.70
Pécs-István tér	32.35	15.98	5.64	2.40	56.37	43.63
Tokod	28.86	8.31	4.63	5.47	47.27	52.73
Avar Period, 6th-8th						
Ártánd	28.61	5.69	6.60	4.99	45.89	54.11
Bačko Petrovo Selo	28.68	12.50	8.82	3.68	53.68	46.32
Gyenesdiás	31.94	19.44	8.11	3.28	62.77	37.23
Gyöngyöspata-Előmály	29.58	10.14	8.31	3.35	51.38	48.62
Kereki-Homokbánya	27.45	1.52	7.79	3.58	40.34	59.66
Avar-Slavic Period, 9th						
Esztergályhorváti	27.09	21.68	9.50	2.63	60.90	39.10
Garabonc I.	31.82	15.55	3.00	2.36	52.73	47.27
Sopronkőhida	35.37	13.54	8.63	1.72	59.26	40.74
Zalaszabar-Dezsősziget	37.61	22.38	8.07	2.57	70.63	29.37
Early Middle Age, 10th-11th						
Püspökladány I.	29.81	10.40	11.15	4.10	55.46	44.54
Püspökladány II.	28.74	9.97	9.53	5.01	53.25	46.75
Sárbogárd	28.68	5.88	11.54	5.37	51.47	48.53
Late Middle Age, 13th-17th						
Alsórajk-Kastélydomb	28.21	6.42	8.17	5.08	47.88	52.12
Dombóvár-Békató	30.43	9.83	8.14	6.38	54.78	45.22
Fonyód-Vár	27.39	7.80	10.73	5.37	51.29	48.71
Nagytálya	28.29	3.37	6.05	4.93	42.64	57.36
Mean	30.05	10.72	7.83	4.26	52.86	47.14

However, at the same time, the higher mortality rate of 5-14-year-olds in almost all samples questions the validity of using various model life tables as a measure of mortality rates in paleoanthropological series. It also raises the question of whether it is possible at all to draw valid paleoanthropological conclusions from skeletal series studied as a mirrror of old-time communities.

References

ACSÁDI, Gy. and NEMESKÉRI, J. (1970): History of Human Life Span and Mortality. - Akadémiai Kiadó, Budapest.

BERNERT, Zs. (1996): Paleodemográfiai adatok a Kereki-Homokbánya temető népességéről. In: PÁLFI, Gy., FARKAS, Gy. and MOLNÁR, E. (eds): Honfoglaló magyarság - Árpád-kori magyarság. - JATE Embertani tanszéke, Szeged 179-189 pp.

COALE, A. J. and DEMÉNY, P. (1966): Regional Model Life Tables and Stable Populations. - Princeton, New York.

ÉRY, K. (1966): The osteological data of the 9th century population of Ártánd. - Anthrop. Hung. *7*, 85-114.

ÉRY, K. (1967): An anthropological study of the Late Avar period population of Ártánd. - Ann. Hist.-nat. Mus. Nat .Hung. *59*, 465-484.

ÉRY, K. (1967-68): Reconstruction of the tenth century population of Sárbogárd on the basis of archaeological and anthropological data. - Alba Regia *8-9*, 173-196.

ÉRY, K. (1973): Anthropological data to the Late Roman population at Pécs, Hungary. - Anthrop. Hung. *12*, 63-114.

ÉRY, K. (1980): Balkáni eredetű, török kori népesség csontmaradványai Dombóvár határából (The osteological remains of a Turkish period Balkan population in the vicinity of Dombóvár). - A Szekszárdi Béri Balogh Ádám Múzeum Évkönyve *10-11*, 225-298.

ÉRY, K. (1981): Anthropologische Analyse der Population von Tokod aus dem 5. Jahrhundert. In: MÓCSY, A. (ed.): Die spätrömische Festung und das Gräberfeld von Tokod. - Akadémiai Kiadó, Budapest 223-262 pp.

ÉRY, K. (1990): Anthropological studies on an Early Avar period population at Bačko Petrovo Selo (Yogoslavia). - Anthrop. Hung. *21*, 33-53.

ÉRY, K. (1992): Anthropologische Untersuchungen an drei Populationen aus dem 9. Jahrhundert in Westungarn (Gräberfelder Garabonc I und II, Zalaszabar-Dezsősziget).- Antaeus *21*, 337 - 481.

FRÁTER, E. (1993): Embertani és szerológiai vizsgálatok Budapest III. Kaszás-dűlő, Raktárrét római kori népességén (Anthropological and serological studies on a Roman period population at Kaszásdűlő, Raktárrét, Budapest). - Anthrop. Közl. *35*, 39-60.

GARABÁS, Á. (1993): A Gyöngyöspata-Előmály avarkori népesség paleodemográfiai elemzése (Palaeodemographic evaluation of the Avar period population of Gyöngyöspata-Előmály). - Anthrop. Közl. *35*, 89-100.

HÜSE, L., SZATHMÁRY, L. and GURÁLY, E. (1996): Az Észak -Dunántúl egy reprezentatív 10-11. századi népességének szociodemográfiai állapota. In: PÁLFI, GY., FARKAS, GY. and MOLNÁR, E. (eds): Honfoglaló magyarság - Árpád-kori magyarság. - JATE Embertani tanszéke, Szeged 125-135 pp.

K. KOROMPAI, B. (1974): Nagytálya középkori (XII-XVI. századi) templomának belsejében feltárt embertani anyag elemzése. - Egri Múzeum Évkönyve *11-12*, 75-130.

MENDE, B. G. (1996): Alsórajk-Kastélydomb középkori népességének paleodemográfiai vázlata. In: PÁLFI, GY., FARKAS, GY. and MOLNÁR, E. (Eds.): Honfoglaló magyarság - Árpád-kori magyarság. - JATE Embertani tanszéke, Szeged 157-177 pp.

NEMESKÉRI, J. and NOZDROVOCZKY, S. (1963): Demographische Charakteristika. In: NEMESKÉRI, J. (ed.): Die spätmittelalterliche Bevölkerung von Fonyód. - Anthrop. Hung. *6*, 134-136.

SZŐKE, B. M. (1996): Karoling kor (Esztergályhorváti-Alsóbárándpuszta). - In: KÖLTŐ, L. and VÁNDOR, L. (eds): Évezredek üzenete a láp világából. - Kaposvár-Zalaegerszeg 130-131 pp.

T. RENDES, K. (1993): A gyenesdiási avar kori népesség paleodemográfiai vázlata (Palaeodemographic sketch of the Avar Period Population of Gyenesdiás). - Anthrop. Közl. *35*, 83-87.

ACTA BIOL. SZEGED. 42, pp. 31-40 (1997)

TRAUMATIC INJURIES IN OSTEOARCHAEOLOGICAL SAMPLES

M. FINNEGAN[1], A. MARCSIK[2] and R. PAUDITZ[2]

[1]*Department of Sociology, Anthropology and Social Work, Kansas State University, Manhattan, 66503 Kansas, USA;*
[2]*Department of Anthropology, József Attila University, H-6701 Szeged, P.O.Box 660, Hungary*

(Received: December 10, 1996)

Abstract

Traumatic lesions are common in human skeletal remains from most archaeological periods. The site, degree and morphological characteristics of these injuries often indicate the cause and clinical severity. Trauma occurs as a result of inter- and intra-specific conflicts and violent encounters with environmental hazards.

Traumatic and paleopathological lesions from 7th-8th (N=1250) and 10th-11th (N=629) century Hungarian samples were studied using metric, radiographic and gross morphological observation.

The purpose of the present study is to add special cases of traumatic injury to the paleopathological literature: dislocation in the shoulder joint accompanied by severe arthritis; healed compound fracture in a femur complicated by infection, hypertrophic bone development due to traumatic myositis ossificans; osteosclerosis in maxillary bones with flattened nasal bones caused by mid-face fracture; and large holes in frontal and parietal bones due to surgical removal of depressed fracture fragments. Secondary pathosis of these changes and differential diagnoses (arthritis, osteotuberculosis, and developmental anomalies) are emphasized.

Key words: traumatic injuries, osteoarcheological samples, dislocation, fractures, myositis ossificans, trepanation

Introduction

Traumatic lesions are very common in human skeletal remains from most archaeological periods. Trauma occurs as a result of inter- and intraspecific conflicts and violent encounters with environmental hazards. The site, degree and morphological characteristics of these injuries often indicate the cause and clinical severity.

In paleopathology there are many attempts to categorize traumatic lesions. STEINBOCK (1976) divided the lesions into five groups, ORTNER and PUTSCHAR (1981) made use of eight categories, ZIMMERMAN and KELLEY's classification (1982) included more than eight groups, LOVRINČEVIČ and MIKIČ (1989) divided them as fractures, luxations, amputations and cuts.

The purpose of the present study is to add special cases of traumatic injury to the paleopathological literature: dislocation in the shoulder joint accompanied by severe arthritis; healed compound fracture in a femur complicated by infection; hypertrophic bone development due to traumatic myositis ossificans; osteosclerosis in maxillary bones with flattened nasal bone caused by mid-face fracture; and large holes in frontal and parietal bones due to surgical removal of depressed fracture fragments. Secondary pathosis of these changes and differential diagnoses (arthritis, osteotuberculosis and developmental anomalies) are emphasized.

Materials and methods

The skeletal collections of the Department of Anthropology, József Attila University, Szeged, Hungary, served as a source of material for the study of traumatic and other paleopathological lesions.

The samples are derived from the territory of present-day Hungary and are dated from the 7th-8th century (n=654) and the 10th-11th century (n=629).

The paleopathological investigation has been carried out using gross observation supported by radiographic and metric methods.

Special cases on traumatic injuries

Dislocation

site: Szeged-Makkoserdő
specimen number: 241/1480
age: Adult (35-45)
sex: male
date: AD 700-800

Archaeological and anthropological background: The adult, male skeleton in this report was excavated by F. MÓRA and D. CSALLÁNY (in 1930 and 1940) from the Makkoserdő area of Szeged, Hungary. The archaeological remains indicate that this skeleton belonged to the late Avar Period (AD 700-800). Of the 152 skeletons, 41 were infant or juvenile, 57 were adult male, 45 were adult female and 9 were indeterminate (VÁMOS, 1973). Many individuals suffered lesions of the bones and teeth, mostly osteoarthritis, fractures, osteotuberculosis, porotic hyperostosis, congenital anomalies, caries lesions or enamel hypoplasia (MARCSIK, 1978; MARCSIK and BAGLYAS, 1987).

One skeleton, that of a 35-45 year old male (grave no. 241), was especially pathological and showed a unique traumatic lesion.

Gross morphological condition: The following bones are missing for 241/1480: left clavicle, vertebrae C1, C3-C5, the bones of both hands, both naviculare, cuboids, and three cuneiforms in each foot. Of special interest are right scapula and humerus which show an anterior dislocation of the right shoulder. The proximal humerus articulates with a new joint on the anterior surface of the scapula, directly adjacent and medial to the glenoid fossa. A secondary joint is also located on the humerus at the location of the inferior posterior portion of the greater tuberosity. Each of these new joint display a porous surface with extensive arthritic degeneration, including marked eburnation on both scapula and humerus (Fig. 1).

Fig. 1. Szeged-Makkoserdő, no. 241/1480. Dislocation in the right shoulder.

Diagnosis and discussion: The mass of bone inferior to the false joint on the humerus is due to osteophytic invasion (myositis ossificans traumatica) of the tendon (and muscle) of the muscles latissimus dorsi and pectoralis major, especially the anterior lamina, as a result of the traumatic severance of these muscles at this location. A traumatic origin is further suggested by the fact that the humerus is rotated laterally approximately 90° such that the new humeral joint is located on the greater tuberosity and not on the head. This lateral rotation would be the natural action after severing the muscles responsible for medial rotation at the shoulder joint. This is in contrast to a similar condition described by ORTNER and PUTSCHAR (1981). Their case shows less medial displacement and medial rather than the lateral rotation of the humerus as displayed in our case. Similarly, WELLS (1982) described two cases with clear evidence of dislocation in the shoulder joint accompanied by severe arthritis, remodelling of the bones and development of a false joint in a Cirencester skeleton.

In our case the traumatic origin is suggested on the basis of the above mentioned facts rather than a tuberculous infection supposed earlier (MARCSIK and PÁLFI ,1993).

Traumatic myositis ossificans
site: Kiskőrös -Városalatt
specimen number: 81/2654
age: adult
sex: male
date: AD 700-800

Archaeological and anthropological background: The skeletal material is published by LIPTÁK (1983). The archaeological publication of this cemetery was due to HORVÁTH (1935), the material was revised by LÁSZLÓ using his own methods (in LIPTÁK, 1983). The anthropological material studies consists of 49 male and 53 female, 16 juvenile and infants, and 2 indeterminate. In paleopathological aspect the skeletal material is poor. There are no serious cases (slight osteoarthritis, vertebral osteophytosis and porotic hyperostosis (MARCSIK, 1978; 1984). One skeleton has an interesting traumatic lesion: myositis ossificans.

Gross morphological condition: This skeleton is well preserved without any pathological alterations except of the right femur. On the femur there is an exuberant growth of bone on the posterio-lateral aspect of the femur shaft extendings from the insertion of the adductor muscles. The extent and the shape of the bony mass suggests ossification in muscle tissue rather than callus formation. The length of the bony mass is about 15 cm. This type of ectopic bone can be attached or develop in muscle tissue quite apart form the parent bone (Fig. 2).

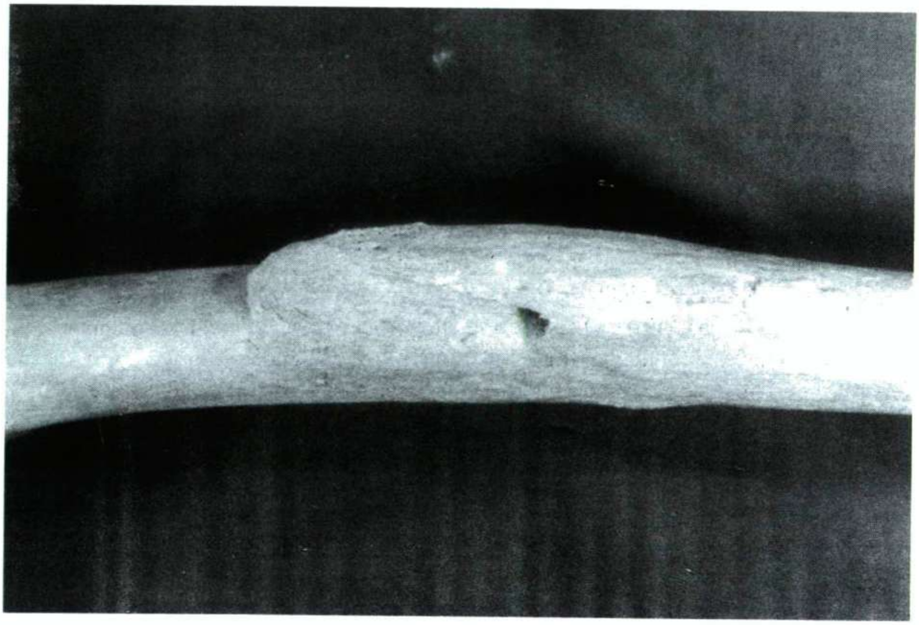

Fig. 2. Kiskőrös-Városalatt, no. 81/2654. Traumatic myositis ossificans on the right femur.

Compound fracture
site: Szeged-Fehértó-A
specimen number: 1772
age: adult
sex: male
date: AD 700-800

Archaeological and anthropological background: The Szeged-Fehértó-A cemetery was excavated by F. MÓRA with K. SEBESTYÉN in 1929-1932. On the basis of the archaeological finds, this skeletal material dated to AD 700-800. Ninety-one male, 88 female, 2 undeterminable adults, and 25 infant and juveniles made up this sample (LIPTÁK and VÁMOS, 1969). Pathology and developmental anomalies abound: craniostosis (scaphocephaly), Stafne idiopathic bone defect, traumatic injuries (parry fractures), porotic hyperostosis, osteoarthritis, and diffuse osteoporosis (MARCSIK, 1978, 1984; FINNEGAN and MARCSIK, 1980, 1981).

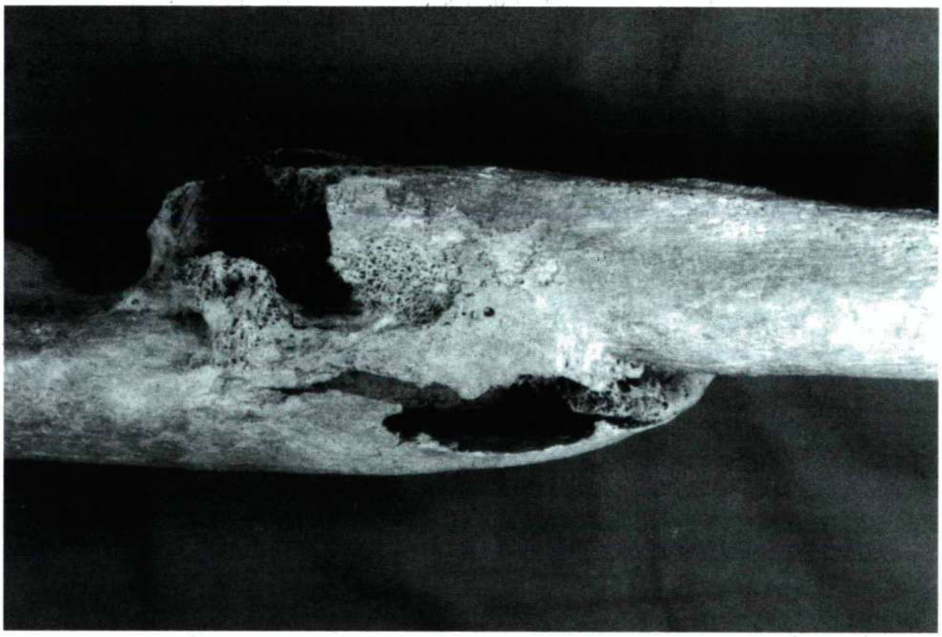

Fig. 3. Szeged-Fehértó-A, no. 1772. Healed compound fracture in the right femur.

One femur of an adult male (no. 1772) showed the trace of a healed compound fracture.

Gross morphological condition: this femur has been separated from the other bones of this individual during the postmortem interval. A compound fracture of this isolated femoral shaft is replete with a large draining sinus. The infected fracture shows considerable disturbance during the healing process, including the development of periostitis and osteomyelitis. The resorption of necrotic bone and the development of new bone are retarded or may not occur at all. The final outcome of the compound fracture depends on the duration of the infection and on the amount of bone lost at the site of fracture. Infections of long duration or involving excessive amounts of bone loss may present bony union. A large sinus tract with a drainage opening indicates that infection was present at the time of death (Fig. 3).

Healed mid-face and nasal fracture
site: Püspökladány-Eperjesvölgy
specimen number: 621/85. 542. 1.
age: juvenile (18-20)
sex: female
dated: AD 1000-1100

Archaeological and anthropological background: This juvenile female skeleton is one of 368 adults, 43 juveniles, 206 infants and 12 indeterminate skeletons excavated from the cemetery at Püspökladány-Eperjesvölgy (eastern part of Hungary) by I. NEPPER between 1977 and 1982 (SZATHMÁRY and HÜSE, in press; PAUDITZ, 1995). Many paleopathological lesions were observed in this skeletal material (PAUDITZ, 1995): sacral spina bifida, sacralization as a developmental anomaly, non-specific infections (mastoiditis, periostitis), osteotuberculosis (?), signs of hematogenous and metabolic diseases, arthritis in many specimens and benign tumor. Traumatic lesions are seen as, fractures in 6 individuals, symbolic trepanation on 5 skulls, and surgical trepanations followed by cutting in three cases. One specimen (grave 621) is very special for mid-face and nasal injuries.

Gross morphological condition: a portion of the maxilla, near the nasal cavity, is sclerotic. Consequent to injury, the nasal cavity is narrowed, the nasal bones are partially fused, very flat, and do not protrude. Inside the nasal cavity there are signs of periostitis, the ridge of the nasal cavity is rough and uneven, and an incisive suture can be seen. There is a partial absence of the premaxilla region, total absence of the upper incisors, and an abnormal communication between nasal and oral cavities. The palatal dental arch is narrower than in the normal case. The upper incisors were probably protruded (not alveolar prognathism) based on the direction of the sockets of the upper canines. A blow to the nasal region could have affected the nasal bones above and the maxillae below causing a radiating fracture (Fig. 4) with subsequent fracturing and resorption of the adjacent alveolar process of the intermaxilla. The results of the post-traumatic inflammation (probably with infection) are seen in fused nasal bones and a narrowed nasal cavity (a 10 mm breadth where normal breadth is 25 mm).

Discussion and diagnosis: this bilateral healed mid-face fracture extends across the anterior facial region. There is no evidence of osteomyelitis (only periostitis) in the nasal cavity. The fracture lines are indicated on x-ray picture by the visible radiolucent area surrounded by thickened bone (MARCSIK and KOCSIS, in press). Based on the degree of healing and remodeling, the injury (blow?) occurred quite some time before death.

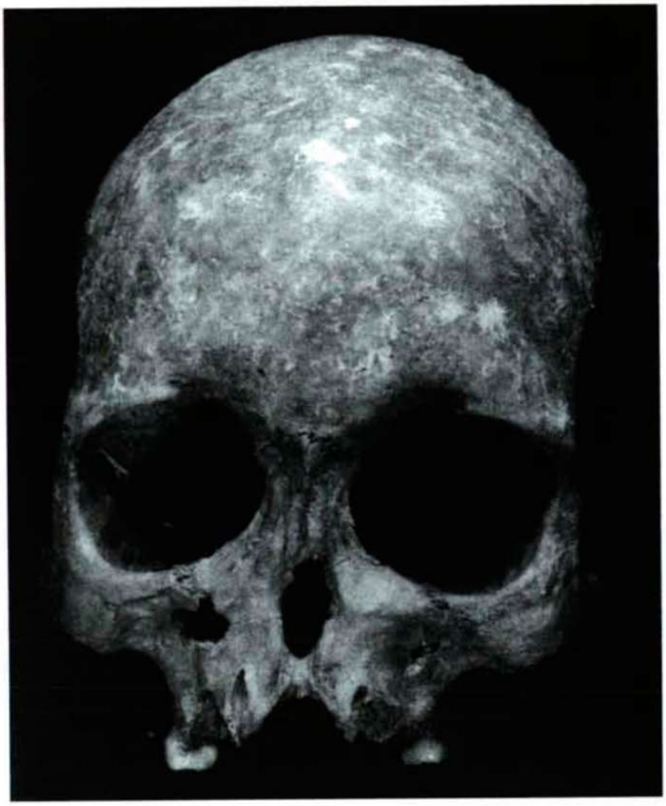

Fig. 4. Püspökladány-Eperjesvölgy, no. 621/85. 542. 1. Healed mid-face and nasal fracture.

Removal of fractured fragments surgery trephination
site: Püspökladány-Eperjesvölgy
specimens number: 147/85. 112. 1, 299/85. 236. 1, and 26/85. 24. 1.
age and sex: no. 147 a mature male; no. 299 an adult female; no. 26 an adult male (see the case above for cemetery demographics)

Grave no. 147: the lesion is confined to the frontal bone. There is a large hole which is probably due to a removal of depressed fracture fragment(s) during surgery (Fig. 5). There is evidence of significant healing, indicating that the patient had not died during or immediately after trephination. (Grave no. 26: the lesion is similar to no. 147).

Grave no. 299: extensive trephination: this large lesion lies primarily between the frontal and parietal bone (Fig. 6). As seen by the considerable bone remodeling, this individual survived the trephination for an extended period of time.

Fig. 5. Püspökladány-Eperjesvölgy, no. 147/85. 112. 1. Removal of fractured fragments surgery trephination.

Summary

The specimens reported here showing dislocated shoulder, mid-face fracture, myositis ossificans traumatica and the surgical trephination of fractured fragments, are interesting traumatic/pathological cases found in a series of over 3000 skeletons studied from southern and eastern Hungary representing the Late Avar period (7th and 8th century) and the Hungarian Conquest period and early Arpadian age (10th century and 11th century).

This research was supported by the National Scientific Research Foundation (OTKA grant No. T016549), for which the authors are grateful.

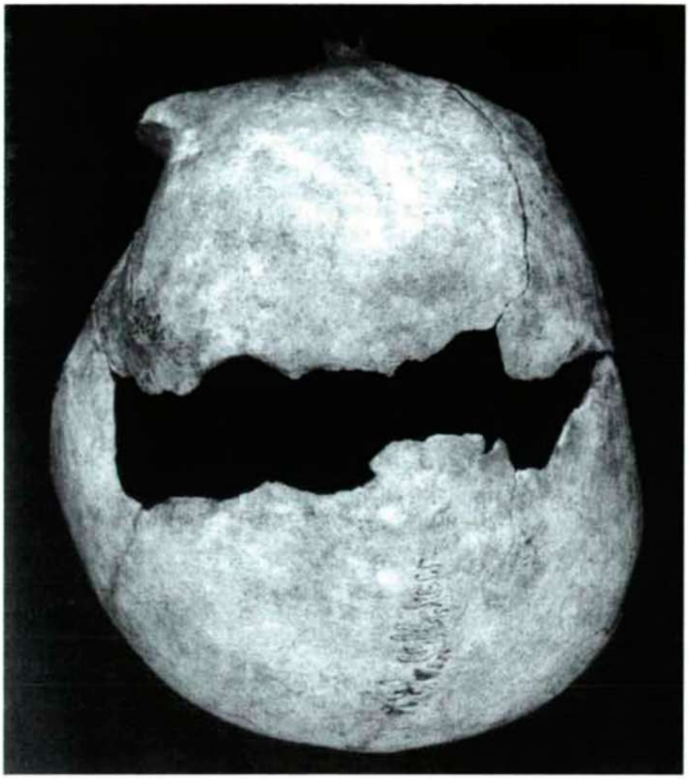

Fig. 6. Püspökladány-Eperjesvölgy, no. 299/85. 236. 1. Removal of fractured fragments surgery trephination.

References

FINNEGAN, M. and MARCSIK, A. (1980): Anomaly or Pathology: the Stafne defect as seen in archeological material and modern clinical practice. - J. Hum. Evol. *9*, 19-31.

FINNEGAN, M. and MARCSIK, A. (1981): The description and incidence of the Stafne idiopathic bone defect in six avar period populations. - Acta Biol. Szeged. *27*, 215-221.

LIPTÁK, P. (1983): Avars and Ancient Hungarians. - Akadémiai Kiadó, Budapest.

LIPTÁK, P. and VÁMOS, K. (1969): A "Fehértó-A" megnevezésű avar kori temető csontvázanyagának embertani vizsgálata. - Anthr. Közl. *13*, 3-30.

LOVRINČEVIĆ, A. and MIKIĆ, Z. (1989): Atlas of osteopathologic changes of the historical Yugoslav populations. - Svjetlast, Sarajevo.

MARCSIK, A. (1978): Comparative evaluation of pathological avar findings excavations between the Danube and Tisza rivers. - Acta Biol. Szeged. *24*, 143-150.

MARCSIK, A. (1984): A Duna-Tisza köze avar korának paleopatológiája. - Dissertation for candidate degree, Manuscript.

MARCSIK, A. and BAGLYAS, B. (1987): The frequency of enamel hypoplasia from the 8th century, Hungary. J. Paleopath. *1*, *1*,25-32.

MARCSIK, A. and KOCSIS, G. (in press): Facial defects in historic skeletal sample. In: Proccedings of Perspectives in Anthropology of Past and Present Populations. E. M. WINKLER Memorial Symposium. Greece.

MARCSIK, A. and PÁLFI,Gy. (1993): Data for the epidemiology of skeletal tuberculosis in ancient populations. - Czlowiek w czasie i przestrzeni, Gdansk, 354-358.

ORTNER, D. and PUTSCHAR, W. G. J. (1981): Identification of Pathological Conditions in Human Skeletal Remains. - Smithsonian Contributions to Anthropology. *28*. Washington. USA.

PAUDITZ, R. (1995): A lepra epidemiológiai vonatkozásai. Püspökladány-Eperjesvölgy X-XI. századi széria leleteinek paleopatológiai jellemzése. - Diplomawork, Manuscript.

STEINBOCK, R. T. (1976): Paleopathological diagnosis and interpretation. Bone diseases in ancient human populations. - Charles C. Thomas. Springfield. Illinois. USA.

SZATHMÁRY, L. and HÜSE, L. (in press): Püspökladány-Eperjesvölgy 10-11. századi népességének paleodemográfiai és paleoszociológiai rekonstrukciója. - DMÉ.

VÁMOS, K. (1973): "Szeged-Makkoserdő" avar kori népességének embertani vizsgálata. - Antr. Közl. *17*, 29-39.

WELLS, C. (1982): The Human Burials. In: Mc WHIRR, A., VINER, L. and WELLS, C. (eds): Romano-British cemeteries at Cirencester. - Cirencester Excavation Committee, 175-176.

ZIMMERMAN, M. R. and KELLEY, M. A. (1982): Atlas of Human Paleopathology. - Praeger Publisher, New York, USA.

ACTA BIOL. SZEGED. 42, pp. 41-47 (1997)

ANTHROPOLOGICAL ANALYSIS OF THE SEMMELWEIS STREET CEMETERY AT VÁRPALOTA

E. FÓTHI

Department of Anthropology, Hungarian Natural History Museum, H-1062 Budapest, Bajza u. 39., Hungary

(Received: January 17, 1997)

Abstract

Anthropological research was carried out on 34 skeletal remains from the Hungarian Conquering Period cemetery at Várpalota, Semmelweis Street. The number of infants was very high (35%). The women exhibited a markedly worse mortality than that of the men. The comparison of the men and the women indicated some differences. The majority of the men had short or very short, wide and low skulls. This same type also occurred among the women, but less frequently. Another type, in almost the same ratio, had a very long, narrow and comparatively low brain-case, with a high and narrow face. These two groups seemed to indicate some traces of social status differences. The variations in cranial build suggested some degree of advance in the mixing of the conquerors and the autochthon population. It is justified to consider some of the women to have been of autochthonous origin.

Key words: Várpalota, Hungarian Conquering Period, palaeoanthropology, palaeosociography.

Introduction

The lack of human findings has made the 10th century history of Veszprém County rather obscure within the context of Hungarian history just after the conquest. The anthropological character of the county's population has no firm outlines in the historical past. Only a pathological description has been published on the Neolithic finding from József Attila Street in the town of Veszprém (BARTUCZ, 1966). Detailed anthropological analyses have been reported on the Celtic Period cemeteries at Csabrendek and Cserszegtomaj (NEMESKÉRI and DEÁK, 1954), the German Period cemetery at Várpalota (MALÁN, 1952), and the Avar Period cemeteries at Veszprém-Jutas and Öskü (BARTUCZ, 1930, 1931). The Avar Period site at Ugod-Huszárokelő has been described only in a pathological case-study (BARTUCZ, 1966). ACSÁDI and NEMESKÉRI (1957) published detailed anthropological data on 42 skulls from the finds at Veszprém-Kálváriadomb, Veszprém-Újtelep and Veszprém-Sashegy, all dated to the 10th-11th centuries. In 1978, KRALOVÁNSZKY and ÉRY started a new excavation to uncover the St. Miklós church completely and to complement the data from the 1929-30 excavation of Rhé at Veszprém-Kálváriadomb. The earliest graves in the Kálváriadomb cemetery were dated to the middle of the 11th century, and the latest to the middle of the 16th century; these findings therefore provide a picture of the late medieval inhabitants of the town of Veszprém (ÉRY, 1983). No publication is available on any anthropological findings dated expressly to the 10th century. We have now analysed skeletal material excavated S. PERÉMI at Semmelweis Street in Várpalota.

Material and method

From an excavation in the garden at No. 55, Semmelweis Street in the Loncsos district of the town of Várpalota, the remains of 7 individuals were uncovered in 1985-86 (S. PERÉMI, 1987), then those of 13 persons in 1987 and those of another 15 individuals in 1988 (S. PERÉMI, personal communication).

Though this was only a portion of the original cemetery, there is no possibility to go on with the excavation and so it is justified to publish these findings. The skeletal remains found in 34 graves constitute the object of the analysis. The majority of the graves were oriented in the north-west - south-east direction. The skeletal material is housed at the LACZKÓ DEZSŐ Museum in County Veszprém. The anthropological examinations were carried out in the Hungarian Natural History Museum.

Sex was determined by the complex method of ÉRY et al. (1963). Estimation of age at the time of death was based on the eruption of the teeth for the children (FEREMBACH et al., 1979) and on the size of the long bones (STLOUKAL and HANÁKOVÁ, 1978). For the juveniles, it was determined by considering the ossification of the epiphysis cartilage with juveniles (SCHINZ et al., 1952). The ages of the adults at the time of death were assessed on the basis of the external cranial sutures (MEINDL and LOVEJOY, 1985), by the method of the BROOKS and SUCHEY (1990) based on the changes in the surface of the os pubis, by the method of LAMENDIN et al. (1992) based on the transparency changes in the monoradicular teeth and by examining the wear of the masticatory surface of the molars according to the method of BROTHWELL (1963).

The metric characteristics of the skulls and of the skeletons were analysed according to MARTIN and SALLER (1957). The classification of measurements and indices was based on the categories of ALEKSEYEV and DEBETS (1964).

Stature was estimated by the method of SJØVOLD (1990).

Results and discussion

Demography

The remains of 16 subadult and 18 adult individuals were examined. The adult group consisted of 9 males and 9 females. This balanced ratio of the sexes indicated a peaceful and continuously coexisting population. Two of the adult men died at an adult age, 5 died at a mature age, and 2 died at a senile age. Three women died as adults, and 6 at a mature age. Not a single woman survived until senile age. The high ratio (47%) of subadults indicates the poor conditions of life. There were 6 children of infant I age (0-6 years), and another 6 of infant II age (7-14 years). Four persons died at a juvenile age (15-20 years). Sex estimations on this age group revealed 1 male and 3 females.

The trends typical for the Middle Ages held true for Várpalota. The infant mortality was very high: the infants accounted for 35% of the individuals, while the infants and juveniles together accounted for 47%. The women exhibited markedly worse mortality indices than those of the men.

Anthropometric features

The individual skull measurements and indices are listed in Tables 1 and 2. The material was extremely incomplete. In a very considerable number of cases, the facial skeleton was damaged and incomplete beyond any possibility of reconstruction. Therefore, conclusions could be drawn only on the basis of the brain-cases.

Table 1. Individual data on males.

Grave / Age	2 sen	3 ad	21 juv	23 mat	24 mat	28 mat	30 mat	32 ad	35 sen
M 1	166	-	190	-	187	185	180	-	181
M 1C	169	-	189	-	184	184	178	-	183
M 5	-	-	107	-	104	104	-	-	-
M 8	140	-	141	-	141	148	157	-	150
M 9	97	96	-	-	-	94	-	-	97
M 17	-	-	145	-	135	132	-	-	-
M 20	-	-	-	-	109	116	-	-	-
M 38	-	-	-	-	1408	1518	-	-	-
M 40	-	-	-	-	-	-	-	-	-
M 45	-	-	-	-	-	-	-	-	-
M 46	-	-	-	-	-	-	-	-	-
M 47	-	-	-	-	-	-	-	-	-
M 48	-	-	-	-	-	-	-	-	-
M 51	-	-	-	-	-	-	-	-	-
M 52	-	-	-	-	-	-	-	-	-
M 54	-	-	-	-	-	-	-	-	-
M 55	-	-	-	-	-	-	-	-	-
M 62	-	-	-	-	-	-	-	-	-
M 63	-	-	-	-	-	-	-	-	-
M 65	-	-	123	123	130	-	133	120	-
M 66	-	104	95	102	-	-	104	98	-
M 69	-	34	34	32	-	-	27	28	-
M 70	-	-	60	62	76	-	69	64	-
M 71	-	31	36	33	30	-	34	25	-
8:1	84.33	-	-	-	75.40	80.00	87.22	-	82.87
17:1	-	-	-	-	72.19	71.35	-	-	-
17:8	-	-	-	-	95.74	89.19	-	-	-
9:8	69.29	-	-	-	-	63.51	-	-	64.67
47:45	-	-	-	-	-	-	-	-	-
48:45	-	-	-	-	-	-	-	-	-
52:51	-	-	-	-	-	-	-	-	-
54:55	-	-	-	-	-	-	-	-	-
63:62	-	-	-	-	-	-	-	-	-
Stature (SJØVOLD)	170 cm	164 cm	173 cm	167 cm	180 cm	167 cm	175 cm	167 cm	170 cm

The brain-cases of the men were mostly short or very short. Two of the 6 measurable male skulls were dolichocranic, 2 were brachycranic and 2 were hyperbrachycranic. There were 2 high and 2 low skulls when compared to cranial length. Three foreheads were narrow, and 1 was medium wide. The skull capacity was medium in 2 cases and large in 1 case. The stature also varied between wide margins. The average stature was 170 cm, 1 cm higher than the average stature for the period (ÉRY, 1996).

Table 2. Individual data on females.

Grave Age	1 juv	4 mat	7 mat	10 ad	11 juv	14 ad	18 mat	25 mat	33 ad
M 1	165	188	191	179	167	171	170	185	174
M 1C	-	185	183	179	168	176	173	-	177
M 5	97	98	-	100	91	97	-	102	95
M 8	143	134	140	142	146	143	138	137	138
M 9	91	92	95	103	98	97	100	-	93
M 17	122	130	-	126	130	127	-	129	123
M 20	113	107	110	110	109	-	106	-	110
M 38	1296	1307	1399	1345	1293	-	1268	-	1287
M 40	-	87	-	93	80	95	-	-	95
M 45	-	120	-	130	128	-	-	-	118
M 46	88	-	-	99	97	-	-	-	89
M 47	-	110	-	111	112	-	-	-	112
M 48	-	69	-	66	68	71	-	-	65
M 51	40	44	-	43	40	43	-	-	40
M 52	32	34	-	32	32	35	-	-	29
M 54	21	23	-	27	24	26	-	-	23
M 55	-	48	-	49	49	51	-	-	48
M 62	-	-	-	-	42	-	-	-	46
M 63	37	-	-	-	38	-	-	-	38
M 65	-	116	118	121	113	127	108	115	-
M 66	92	96	100	100	90	95	90	95	-
M 69	28	30	29	29	30	30	32	29	-
M 70	51	59	65	60	60	69	33	63	53
M 71	30	29	30	30	33	28	58	29	28
8:1	86.66	71.28	73.30	79.33	87.42	83.63	81.17	74.05	79.31
17:1	73.94	69.15	-	70.39	77.84	74.27	-	69.73	70.69
17:8	85.31	97.02	-	88.73	89.04	88.81	-	94.16	89.13
9:8	63.63	68.66	67.86	72.53	67.12	67.83	72.46	-	67.39
47:45	-	91.67	-	85.39	87.50	-	-	-	94.91
48:45	-	57.50	-	50.77	53.13	-	-	-	55.08
52:51	80.00	77.27	-	74.42	80.00	81.39	-	-	72.50
54:55	-	47.92	-	55.10	48.98	50.98	-	-	47.92
63:62	-	-	-	-	90.48	-	-	-	82.61
Stature (SJØVOLD)	157 cm	152 cm	152 cm	164 cm	156 cm	158 cm	161 cm	163 cm	156 cm

There were 9 female skulls suitable for analysis. Three of these were very long and narrow (hyperdolichocranic), 2 were medium long (mesocranic), 2 were short (brachycranic) and 2 were very short and very wide (hyperbrachycranic). The women were characterized by rather low skulls. Only the faces of very few individuals could be evaluated, because of the extremely fragmentary condition of the material. The faces of the women were mostly medium high or high, the orbital cavities were low, and the noses were medium narrow. The average stature was 158 cm.

The comparison of the men with the women revealed some differences. The majority of the men had the short or very short, wide and low skulls that predominate in the cemeteries dated to the 10th century in the first settlement territories of the conquering Hungarians in the Great Hungarian Plain and in the Upper-Tisza Region. This same type also occurred among the women, but less frequently. Besides this type, another one displayed almost the same ratio: this was a type with a very long, narrow and comparatively low brain-case, with a high and narrow face. These two groups seem to indicate some traces of social status differences. Three of the women had ornamented attire (Graves 1, 11 and 13). One of them (Grave 13) was impossible to examine because of the poor state of preservation; the other 2 were hyperbrachycranic, i.e. not long-headed.

A brief analysis of the cemetery

Very limited information was found on the sequence of burials. The only skull in the cemetery that displayed symbolic trepanation was in Grave 35 on the edge of the area excavated. Symbolic trepanation was a custom of the conquering Hungarians to the extent that it almost bore an ethnical indicator role. This pagan healing process was spread by the conquering Hungarians. In the 10th century, it occurred almost exclusively in the regions to the east of the Danube. The gradual occupation of the Carpathian Basin spread this custom to Transdanubia. At the end of the 11th century, symbolic trepanation disappeared, together with the other elements of pagan rituals, as Christianity gained power (NEMESKÉRI et al., 1960).

The graves were arranged in lines within the cemetery. The distribution of the adults was by sex, and indicated their burial in the sequence of death or the arrangement of burials by families, as suggested by the cumulative occurrence of certain anthropological features among those buried close to each other. The expressed shovel-shaped upper incisors and the filled-up fossa canina of the individuals in Graves 10, 11, 12 and 13 are two of these features. Shovel-shaped upper incisors are predominantly hereditary Mongoloid characteristics and their cumulative occurrence in persons buried close to each other strongly indicated some kinship. It is noteworthy that the majority of the grave-goods came to light from these graves.

The men buried in Graves 8 and 28 both suffered from hip-joint displasia. This bone deformation is polygenetically hereditary, with a congenital origin. Its occurrence is very rare among adults of historical populations. Two cases in this small, 34-grave sample indicated close kinship.

Palaeosociographic analysis

ÉRY and KRALOVÁNSZKY (1963) laid the foundations of a new and promising complex approach. They compared the archaeological material of nine 10th-11th century cemeteries from the Székesfehérvár region with anthropological observations on the same cemeteries. Analysis of the the Várpalota Semmelweis Street cemetery according to the same principles permits the following conclusions:

1. The proportion of individuals buried with grave-goods (53%) was almost the same as that of individuals buried without grave-goods (47%). However, there are differences according to sexes and age groups. While 60% of the men received no grave-goods at all, only 33% of the women and 50% of the children were buried without them. All juveniles had some grave-goods.

2. As concerns the numbers of grave-goods, the graves of 3 juvenile women contained the highest numbers. Pressed silver plate diadems, earrings, a silver chain, a bronze button, a shell and a wristlet came to light from Grave 1. Grave 11 contained headdress ornaments, earrings, a bronze button, a shell, a bronze pendant, a buckle,

small metal buttons, armlets, pearls and a needle-holder. An earring, a necklace, small bronze buttons, dress ornaments, wristlets and a ring were uncovered in Grave 13.

3. The grave-goods were categorized into three classes (ornaments and jewels, tools and weapons, and ritual objects) and this led to the following conclusions:

a. Half of the graves with grave-goods contained only dress ornaments or some sort of jewellery; these were all graves of women and children. Women and probably little girls were buried in ornamented dresses and bejewelled. Men were buried in plain clothes, even with no buttons. Adult men wore no jewels at all. There was only one male with a single earring and he was of juvenile age.

b. Only 4 graves contained anything that could be classified as economic tools. One adult man, 1 juvenile man and 1 child of 9-10 years had iron knives, while 1 young juvenile woman had a needle-holder. Two graves contained some sort of weapon: Graves 14 and 30 each held 2 iron arrowheads.

c. Only a cross (Grave 12, Infant II) and a small clay pot (Grave 22, Infant II) could be classified as ritual objects. The former can be considered a Christian, and the latter a pagan ritual object.

d. No grave contained saddlery, horse bones or other animal bones. The characteristic types of objects of the earliest conquering Hungarians were missing from this cemetery. It is a well-known fact that the triumph of Christianity meant the annihilation of ancient pagan practices. The small number of ritual objects, weapons, tools and the limited amount of food buried with the dead indicated that this cemetery preserved remains not of the original conquering Hungarians, but of their descendants from several generations later.

Conclusions

A comparison of the anthropological material from the Várpalota Semmelweis Street cemetery with that from other series in Veszprém County reveals that the build of the skulls is most similar to that at the Veszprém-Sashegy site (ACSÁDI and NEMESKÉRI, 1957). The population buried at Veszprém-Kálváriadomb had a much higher ratio of short and very short-headed individuals (ÉRY, 1983). This has much more to do with brachycephalization than with the differences in the populations. The Veszprém-Kálváriadomb population probably lived several centuries later; as throughout medieval Europe, in Hungary, this was the period of the phenomenon (its background is still unclear) of the shortening of the shape of the head in a given population (RÖSING and SCHWIDETZKY, 1978).

The sociographic and anthropologic characteristics of the people buried in the cemetery at Várpalota Semmelweis Street indicated that they could be descendants of the conquering Hungarians from the end of the 10th century and from the 11th century. The oldest part of the cemetery was probably located in the area to the west of Grave 35 and the graves uncovered represented the later part of the population. The variations in cranial build seemed to point towards some degree of advance in the mixing of conquerors and the autochthonous population. It is justified to consider that some of the women were of autochthonous origin. It is not probable that long-headed, autochthonous elements could be descendants of the Várpalota langobards. While the langobard skulls were characterized by a predominance of the Nordic type, besides dolichocrany (MALÁN, 1952), the dolichocranic skulls at Várpalota Semmelweis Street were of the gracile Mediterranean type.

References

ACSÁDI, Gy. and NEMESKÉRI, J. (1957): Contributions à la reconstruction de la population de Veszprém X^e et XI^e siecles. - Annls hist.-nat. Mus. Nat. Hung. *8*, 435-467.

ALEXEYEV, V. P. and DEBETS, G. F. (1964): Kraniometrija. - Nauka, Moszkva.

BARTUCZ, L. (1930): Die anthropologischen Ergebnisse der Ausgrabungen von Jutas und Öskü. - Skythica *4*, 1-16.

BARTUCZ, L. (1931): Anthropologische Ergebnisse der Ausgrabungen von Jutas und Öskü. - Seminarium Kondakovianum, Prága, 75-95.

BARTUCZ, L. (1966): A praehistorikus trepanáció és orvostörténeti vonatkozású sírleletek. Palaeopathologia III., - Az Országos Orvostörténeti Könyvtár Kiadványa, Budapest.

BROOKS, S. and SUCHEY, J. M. (1990): Skeletal age determination based on the os pubis: a comparison of the Acsádi-Nemeskéri and Suchey-Brooks method. - Hum. Evol. *5*, 227-238.

BROTHWELL, D. R. (1963): Digging up bones. The excavation, treatment and study of human skeletal remains. - British Museum, London.

ÉRY, K. (1983): Embertani adatok Veszprém középkori népességéhez. - Veszprém Megyei Múzeumok Közleményei *16*, 87-118.

ÉRY, K. (1996): Honfoglaló magyarság - Árpád-kori magyarság a testmagasság tükrében. In PÁLFI, Gy., FARKAS, L. Gy. and MOLNÁR, E. (eds): Honfoglaló magyarság - Árpád-kori magyarság. - JATE Embertani tanszéke, Szeged, 103-112 pp.

ÉRY, K. and KRALOVÁNSZKY, A. (1963): Székesfehérvár-környéki X-XI. századi temetők népességének paleoszociográfiai vizsgálata (Paleo-sociographical examination of the population of 10th-11th century cemeteries near Székesfehérvár). - Alba Regia *2-3*, 69-89.

ÉRY, K., KRALOVÁNSZKY, A. and NEMESKÉRI, J. (1963): Történeti népességek rekonstrukciójának reprezentációja (A representative reconstruction of historic population). - Anthrop. Közl. *7*, 41-90.

FEREMBACH, D., SCHWIDETZKY, I. and STLOUKAL, M. (1979): Recommandation pour détermier l'age et le sexe sur le squelette. - Bull. et Mém. de la Soc.d'Anthrop. de Paris *13*, 7-45.

LAMENDIN, H., BACCINO, E., HUMBERT, J. F., TAVERNIER, J. C., NOSSINTCHOUK, R. M. and ZERILLI, A. (1992): A Simple Technique for Age Estimation in Adult Corpses: The Two Criteria Dental Method. - J. For. Sci. *37*, 1373-1379.

MALÁN, M. (1952): Zur Anthropologie des langobardischen Gräderfeldes in Várpalota. (A Várpalotai langobard temető embertani vizsgálata). - Annls Hist.-nat. Mus. Nat. Hung. *3*, 257-275.

MARTIN, R. and SALLER, K. (1957): Lehrbuch der Anthropologie. - Fischer Verlag, Stuttgart.

MEINDL, R. S. and LOVEJOY, C. O. (1985): Determination of skeletal age at death based on the lateral-anterior sutures. - Am. J. Phys. Anthr. *68*, 57-66.

NEMESKÉRI, J. and DEÁK, M. (1954): A magyarországi kelták embertani vizsgálata. - Biol. Közl. *2*, 133-158.

NEMESKÉRI, J., ÉRY, K. and KRALOVÁNSZKY, A. (1960): A magyarországi jelképes trepanáció. - Antrop. Közl. *4*, 3-31.

RÖSING, F. W. and SCHWIDETZKY, I. (1978): Vergleichend-statistische Untersuchungen zur Anthropologie des frühen Mittelalters (500-1000 n.d.Z.). - Homo *29*, 65-115.

SCHINZ, H., BAENSCH, W., FRIEDL, E. and UEHLINGER, E. (1952): Ossifikationstabelle. In: Lerhbuch der Röntgen-Diagnostik, 5. Aufl. - Thieme, G., Stuttgart.

S. PERÉMI, Á. (1987): Honfoglalás kori leletek Veszprém megyében. - Veszprém Megyei Múzeumok Közleményei *18*, 115-133.

STLOUKAL, M. and HANÁKOVÁ, H. (1978): Die Länge der Längsknochen altslawicher Bevölkerungen unter besonderer Berücksichtigung von Washstumsfragen. - Homo *29*, 53-69.

SJØVOLD, T. (1990): Estimation of stature from long bones utilizing the line of organic correlation. - Hum. Evol. *5*, 431-447.

ACTA BIOL. SZEGED. 42, pp. 49-53 (1997)

A SERIOUS DEFECT OF TWO CERVICAL VERTEBRAE FROM A MEDIEVAL CEMETERY IN POLAND; KLIPPEL-FEIL SYNDROME?

J. GŁADYKOWSKA-RZECZYCKA

Department of Anatomy and Anthropology, J. Śniadecki University School of Physical Education, Wiejska 1 str., 80-836 Gdańsk, Poland

(Received: December 10, 1996)

Abstract

A probable case of Klippel-Feil syndrome is presented along with a short review of studies on congenital fusion of cervical vertebrae in contemporary and ancient populations. Such disturbances are probably of either genetic or paragenetic origin and seem to be on the increase.

Key words: KLIPPEL-FEIL syndrome?, Middle Ages, Poland.

At a medieval cemetery (12th-13th c.) in Czarna Wielka in north-eastern Poland, about 250 human skeletons were unearthed together with some separate bones that proved difficult to ascribe to the skeletons from the site. Among the separates bones, two cervical vertebrae fused together were found; they were classified subsequently as C4 and C5 or possibly C5 and C6. They were fused by their articular processes and partially by their arches, and had their shafts underdeveloped. The shaft of the upper vertebra had only the poorly developed posterior part in the form of a plate of varying thickness, while the lower vertebra had it in its anterolateral portion. The vertebral foramen and the intervebral and transverse foramina were unchanged (Fig. 1).

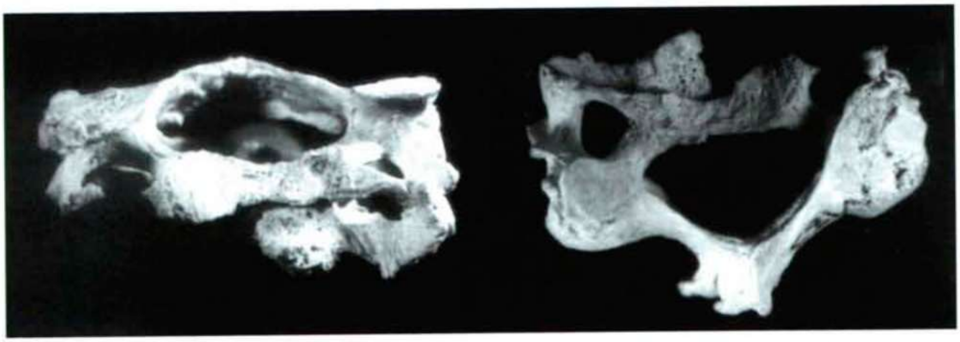

Fig. 1. Two fused cervical vertebrae: C4-5 or C5-6. The articular processes are completely fused and the arches only partially. The shafts are underdeveloped as incomplete plates: there is only an incomplete plate as the posterior part of C4 (or C5) and anterior-lateral (left) part of C5 (or C6).
a) top view, b) anterior-superior view.

Developmental disturbances of the skeleton are among those manifesting most commonly. In Poland, one newborn in every thousand is affected by this type of disorder, which generally occurs in the lower portion of the vertebral column (80%) (OSUCHOWSKI et al., 1974). GRAY et al. (1964) claim that the disorder appears more often in the cervical portion of the vertebral column. By 1961, 418 cases of this disorder had been reported in the available literature; the data seem to vary substantially, making the incidence of the defect difficult to determine accurately. Interestingly, fusion of the cervical vertebrae has also been found in animals.

Classification of developmental disorders of the cervical vertebrae is difficult, since the condition is symptomless in many of its forms, or manifests most often in patients over 40-50 years of age and is frequently accompanied by widely varying clinical symptoms (OSUCHOWSKI et al., 1974; ELSTER, 1984; PRUSICK et al., 1985).

Several forms of cervical segment developmental disorders have been distiguished: 1) atlanto-occipital vertebra fusion, 2) KLIPPEL-FEIL syndrome, 3) odontoid process deformation, 4) spina bifida, 5) hemivertebrae (ZAKRZEWSKI, 1956; KOZINA et al., 1965; PRUSEK et al., 1972).

The KLIPPEL-FEIL syndrome is the most frequently described such defect it can be found, among others, in the works of ZAKRZEWSKI (1956), KOZINA et al. (1965), GUNDERSON et al. (1969), TRAUENFELLNER (1968), MCLAY and MARAN (1969), BAGA et al. (1969), RASSUMOWSKA and MALINOWSKI (1970), PRUSEK et al. (1971), RAMSEY and BLIZNAK (1971), PALANT and CARTER (1972), JUZWA et al. (1973), ROZENBLAT and UTZIG (1973), PRUSZEWICZ and OTREMBOWSKI (1974), HENZINGER et al. (1974), MOORE et al. (1975), and in my other studies cited in this paper.

According to MCLAY and MARAN (1969) and their citation of the work of P. A. and L. GJØRUP from 1964, the condition of a congenital cervical vertebra anomaly was first indicated by HALLER following a post mortem examination in 1745. Only one year later, MORGAGNI discovered in an old man an atlanto-occipital fusion, together with one between the atlas and the third vertebra, and the condition was further characterized by some deformation of ligaments of the occipitovertebral joints (GRAY et al., 1964). The latter source also cites others who described this defect in a newborn (GOODHARD, 1874), in a dwarf (Varaglia), in a patient with the concurrent defect of SPRENGEL (HITSCHINSON, 1894), and in a woman who also had the seventh cervical vertebra fused with the first thoracic vertebra (WILLETT and WALSHAM, 1880; cited by GRAY et al., 1964).

The first cases of the condition in living persons were reported in 1902 by SICK, and by CLARK in 1906, and then other cases gradually became known (GRAY et al., 1964). In 1912, KLIPPEL and FAIL published several articles with a detailed description of cervical vertebra defects in a 46-year-old man. The outstanding feature in the patients was a very short, almost immobile neck, with prominent wing-like soft tissue on both sides thereof (pterigium colli) and a low-lying posterior hairline (MCLAY and MARAN, 1969; PALANT and CARTER, 1972). In 1919, FEIL presented 14 cases of the congenital deformation of cervical vertebrae and categorized the condition into three types:

Type I: a block fusion of all the cervical and upper thoracic vertebrae;

Type II: a fusion of one or two pairs of cervical vertebrae, frequently C1 to C3, or C3 to C4, and accompanied by hemivertebrae, occipito-atlantis;

Type III: combines the anomalies of type I or II with either lower thoracic or lumbar intervertebral fusion (PALANT and CARTER, 1972; MOORE et al., 1975).

In 1921, DUBREUIL-CHAMBARDEL first used the now familiar eponym of KLIPPEL-FEIL.

The classic triad of KLIPPEL-FEIL syndrome features has become known under various synonymous labels: cervical synostosis, congenital brevicollis, Kurzhals, l'homme sans cou, Froschhals (TRAUNFELLENER, 1968; URUNUELA and ALVAREZ, 1994).

Among the material of 418 cases presented by GRAY et al. (1964), the most frequent defect was of type II, block C2-3, and less commonly that of C6-7. The KLIPPEL-FEIL syndrome was equally common in both sexes, and in several cases manifested in the family, e. g. in two brothers.

Congenital deformation of the cervical vertebrae can be accompanied by other defects within the same system. In the bone structure, the concurrence of the following deformations have been discovered: skull and face asymmetry, cleft palate, abnormal development of the inner ear, basilar impression, dental anomalies, micrognathia, atlanto-occipital fusion, deformation of the odontoid process, torticollis, spina bifida, narrowness of the medullar channel, stenosis of the intervertebral foramen, SPRENGEL deformity, cervical ribs, fused ribs, and scapula-vertebral column union (RASSUMOWSKA and MALINOWSKI, 1970; RAMSEY and BLIZNAK, 1971; PALANT and CARTER, 1972; JUZWA et al., 1973; OSUCHOWSKI et al., 1973; PRUSEWICZ and OTRĘBOWSKI, 1974; MOORE et al., 1975; ELSTER, 1984; PRUSICK et al., 1985).

The etiology of developmental defects of the vertebral column is not yet fully known. Most likely, the process takes place in the first weeks of embryonic life, when the developmental differentiation of the blastodermic layers and the isolation of the proto-segments or somites occur, which then differentiate into dermatomes and sklerotomes. The latter surround the notochord and the medullary tube, and thus constitute the mesenchymal buds of the vertebrae. The defective developmental factor is most probably genetically or epigenetically determined (KOZINA et al., 1965; HILLER, 1968).

FEIL pointed out that intrauterine injuries and endometritis may provoke irregular segmentation in the first weeks of intrauterine life (DEMJÉN and MARCINKOVÁ, 1965). According to STRAX and BARAN (1975) (cited by URUNUELA and ALVAREZ, 1994), type II may be inherited as a dominant or recessive trait, depending on the vertebrae affected, while type I and type III are apparently of a recessive nature.

In bone material from ancient cemeteries, only a few cases of KLIPPEL-FEIL syndrome have been recorded. The first cervical block was reported by SMITH in an Egyptian mummy dating back to about 500 B. C. (GRAY et al., 1964). In 1923, MCCURDY described another case of the defect, which was classified by JARCHO as KLIPPEL-FEIL syndrome only in 1965. It was observed in an adult man from Poricarcancha in Peru. C6-7 and Th1 were fused, and within the thoracic vertebrae Th3-4-5 were hemivertebrae; on the right, there were 13 ribs, of which the first four were fused at their proximal ends (ORTNER and PUTSCHAR, 1981). A third case, involving the fusion of five cervical vertebrae, was described by UBELAKER in 1978; whose material came from a local cemetery in Modbridge Side, South Dakota. Two cases dating back to pre-Columbian times were discovered in Tanacah, Quintana Roo, and described by SAUL in 1982. Both presented a fusion of the 2nd and 3rd cervical vertebrae (ORTNER and PUTSCHAR, 1981).

In 1994, a very rare case of type I KLIPPEL-FEIL syndrome was described by URUNUELA and ALVAREZ, who presented material dating back to 1450-80 from pre-Hispanic Cholula, Puebla, Mexico. The cases revealed a complete vertebral fusion from the second cervical to the first thoracic vertebrae, and the hypoplastic development of vertebral bodies. The investigated skeleton came from a 30-40-year-old woman, whose other bones presented other anomalies.

The case discovered in Czarna Wielka seems to be the first dating back to the Old World and probably represents type II KLIPPEL-FEIL syndrome, though the diagnosis may not prove absolutely accurate, as it is based only on the presence of developmental defects in two vertebrae (no other bones remained). A differentiation must be made between this defect and the neck deformation resulting from a vertebral column injury, sub-occipital POTT's disease and NELSON syndrome (MOLDENHAUER, 1964; DEMJÉN and MARCINKOVÁ, 1965).

The sporadic incidence of KLIPPEL-FEIL syndrome in the material from ancient cemeteries and the relatively high occurrence of the condition in our contemporary material (e. g. 1:1000) seem to suggest that the factor responsible for the defect has manifested so broadly only in modern times.

Interestingly, in the Polish material obtained from cemeteries such a dramatic developmental defect was discovered in a medieval burial ground, where the incidences of variation and of the defects themselves are particularly high vis a vis the revelant data from other cemeteries, including those from the Neolith (GŁADYKOWSKA-RZECZYCKA,1980, 1989).

Conclusion

A rare case of a congenital cervical vertebra defect was discovered in the material from a medieval burial ground. Vertebrae C4-5 or C5-6 constitute a block and exhibit an underdeveloped shaft in the form of rudimentary plates. This is the first defect of this kind that has been reported from ancient Polish cemeteries so far. Other disturbances of the kind have come exclusively from the New World. A short review of studies on KLIPPEL-FEIL syndrome indicates that the defect occurs relatively often in contemporary Poland (1:1000).

References

BAGA, N., CHUSID, E. L. and MILLER, A. (1969): Pulmonary disability in the KLIPPEL-FEIL Syndrome. - Clin. Orthop. and Related Research 67, 105-110.

DEMJÉN, Š. and MARCINKOVÁ, V. (1965): KLIPPEL-FEIL syndrome and cleft palate. - Acta Chirurg. Plastic. 7, 297-302.

ELSTER, A . D. (1984): Quadriplegia after minor trauma in the Klippel-Feil syndrome. - J. Bone Joint Surg. *66 A (9)*, 1473-1474.

GLADYKOWSKA-RZECZYCKA J. (1980): Developmental disturbances in the skeletal material from ancient Polish cemeteries. - Przegl. Antrop. *46*, 347-362 (in Polish).

GLADYKOWSKA-RZECZYCKA, J. (1989): Congenital anomalies of early Polish man. - Advances in paleopathology, Monographic publication *1*, - J. Paleopath., 111-116.

GRAY, S. W., ROMAINE, C. B., and SKANDALAKIS, J. E. (1964): Congenital fusion of the cervical vertebrae. - Surg. Gynec. Obst. *118*, 373-385.

GUNDERSON, C. H., GREENSPAN, R. H, GLASER, G. H. and LUBS, H. A. (1969): The KLIPPEL-FEIL syndrome: Genetic and clinical reevaluation of cervical fusion. - Medicine *46*, 491-512.

HENSINGER, R. N., LANG, J. F. and MAC EWEN S. D. (1974): KLIPPEL-FEIL syndrome, a constellation of associated anomalies. -J. Bone Joint Surg. *56 a (6)*, 1246-1253.

HILLER, S. (1968): Histology and embryology. In: BOCHENEK A., REICHER, M. (eds): Human Anatomy. - Warsaw, 55-155 pp, (in Polish).

JUZWA, E. and WINIARSKA-MAJCZYNO, M. (1973): Facial asymmetry, disturbances in masticatory organ and maxillo-orthopedic management of KLIPPEL-FEIL syndrome in children. - Czas. Stom. *26*, 10, 1089-1094 (in Polish).

KOZINA, W., SAPER, J. and LEO, W. (1965): Remarks on neurologic disturbances and on X-ray diagnosis of congenital malformations of the cervical spine. - Rheumatol. *3*, 2, 135-145 (in Polish).

MCLAY, K. and MARAN, A. G. D. (1969): Deafness and KLIPPEL-FEIL syndrome. - J. Laryng. Otology *83*, 175-184.

MOLDENHAUER, E. (1964): Zur Klinik des NIELSON-Syndrome. -Dermatol. Wochenschrift *150*, 594-601.

MOORE, W., MATTHEWS, T. J. and RABINOWITZ R. (1975): Genitourinary anomalies associated with KLIPPEL-FEIL syndrome. - J. Bone Joint Surg. *57 A*, 355-357.

ORTNER, D. J., and PUTSCHAR, W. G. J. (1981): Identification of pathological condition in human skeletal remains. - Smithsonian Institution Press, Washington, Skeletal malformations, 346 pp.

OSUCHOWSKI, K., AUGUSTYŃSKI, W. and BŁACH, A. (1974): KLIPPEL-FEIL syndrome. -Wiad. Lek. *27*, 21, 1881-1883 (in Polish).

PALANT, D., I. and CARTER, B. I. (1972): KLIPPEL-FEIL syndrome and deafness. - Am. J. Diseas. Children *123*, 3, 218-221.

PRUSEK, W., CHILMAN, A. and NAWROCKA, E. (1972): Development anomalies of cervical spine. - Pol. Tyg. Lek. *46*, 1809-1813 (in Polish).

PRUSICK, V. R., SAMBERG, I. C. and WESOLOWSKI, D. P. (1985): KLIPPEL-FEIL syndrome associated with spinal stenosis. - J. Bone Joint Surg. *67A (1)*, 161-164.

PRUSZEWICZ, A. and OBRĘBOWSKI, A. (1974): KLIPPEL-FEIL syndrome with coexistent submucosal cleft palate and hypoacusia. - Czas. Stomat. *27*, 3, 251-255 (in Polish).

RAMSEY, J. and BLIZNAK, J. (1971): KLIPPEL-FEIL syndrome with renal agenesis and other anomalies. - Am. J. Roentg. Radium Therapy Nuclear Med. *113*, 3, 460-463.

RASSUMOWSKA, D. and MALINOWSKI, A. (1970): Anthropomorphological characteristics of KLIPPEL-FEIL syndrome with cleft palate. - Czas. Stomat. *23*, 9, 1075-1081 (in Polish).

ROZENBLAT, J. and UTZIG A. (1973): KLIPPEL-FEIL syndrome associated with multiple developmental anomalies. - Pol. Tyg. Lek. *28*, 22, 832-833 (in Polish).

TRAUNFELLNER, Z. (1968): Case of KLIPPEL-FEIL syndrome. - Wiad. Lek. *21*, 6, 521-522 (in Polish).

UBELAKER, D. H. (1978): Human skeletal remains: excavation, analysis, interpretation. - Aldine Publishing Company, Chicago.

URUNUELA, G. and ALVAREZ R. (1994): A report of KLIPPEL-FEIL syndrome in pre-Hispanic remains from Cholula, Puebla, Mexico. - J. Paleopath. *6(1)*, 63-67.

ZAKRZEWSKI, T. (1956): Case of congenital block of cervical vertebrae (KLIPPEL-FEIL syndrome). - Pol. Tyg. Lek. *11*, 842-44 (in Polish).

ACTA BIOL. SZEGED. 42, pp. 55-58 (1997)

TREATMENT OF MISSING DATA IN PRINCIPAL COMPONENT ANALYSIS

ZS. GUBA, L. SZATHMÁRY and L. ALMÁSI

Department of Human Biology, Kossuth Lajos University, Debrecen H-4010, P.O.B. 6, Hungary

(Received: December 20, 1996)

Abstract

Different methods for the substitution of missing data were applied in order to establish how incomplete data affect the correlation pattern of skull measurements. Principal component analysis was first performed on skulls from a real anthropological sample with no missing values. Ten, twenty and thirty per cent of the data were then dropped and the missing data were replaced by three methods: mean substitution, pairwise deletion and DEAR's method. Finally, principal component analysis was carried out on the samples with replaced values. The rotated factor matrices indicated that DEAR's method is most acceptable as concerns the correlation pattern of variables. With this method, considerable changes in the pattern of the measurements were not found after substitution of thirty per cent of the data.

Key words: missing data, PC analysis, correlation pattern.

Introduction

A historical anthropological sample involves more or less fragmentary human skeletal remains. Because of the limited number of human findings from a particular historical period, it would be useful to analyse as many individuals as possible. The number of individuals analysed with multivariate methods can be enlarged by replacing the missing measurements of fragmentary bones. Several missing value methods are used in multivariate analysis. This study compares three methods to examine what percentage of the data can be replaced so that the conclusions based on principal component analysis remain correct. For this purpose, data from a real anthropological sample were used.

Material and method

The sample contains 13 measurements on 33 male skulls from a cemetery (Alattyán-Tulát, Hungary) (Table 1) originating from the Avar Period (WENGER 1957).

In the first step, principal component analysis with the varimax rotation method was carried out on the complete sample. 10, 20 and 30 per cent of the data were then dropped, and the missing values were replaced by three methods: mean substitution, pairwise deletion and DEAR's PC method.

Table 1. Dimensions Used (MARTIN, 1928).

MARTIN no.	Dimensions
1	Maximum cranial length
5	Basi-nasal length
8	Maximum breadth
9	Minimum cranial breadth
17	Basion-bregma height
20	Basion-nasion height
45	Bizygomatic breadth
48	Upper facial height
51	Orbital breadth
52	Orbital height
54	Nasal breadth
55	Nasal height
66	Bigonial breadth

In mean substitution, sample means for the variables are first calculated on the basis of all available sample values. These mean values are then used for the missing values.

With pairwise deletion of missing data, each correlation coefficient is computed, using all cases with valid data for the two variables being correlated.

In DEAR's PC method, the data matrix is replaced by a standardized matrix, where 0 is used for missing values. The coefficients of the first principal component are then obtained; these are the eigenvectors of unit length associated with the largest eigenvalue of the product matrix. Any missing value in the standardized matrix is replaced by the nearest point on the first principal component. After all missing values have been estimated, the standardized matrices are transformed back to their original units (DEAR, 1959, cf. CHAN and DUNN, 1972).

Next, PC analyses with the varimax rotation method were performed on the 9 samples obtained. The results are assessed on the basis of rotated factor matrices.

Results

The complete sample

The means and standard deviation of each variable analysed for the complete sample are shown in Table 2.

Table 2. Means and standard deviations of the variables examined.

MARTIN no.	Mean	SD
1	186.8	6.79
5	102.4	4.26
8	147.4	5.67
9	99.5	4.73
17	130.3	5.99
20	112.9	4.64
45	137.1	4.49
48	69.9	3.61
51	43.0	2.21
52	34.0	2.10
54	26.4	2.02
55	53.0	3.27
66	101.8	7.47

On the basis of the rotated factor matrix of the complete data (Table 3), 75.1 per cent of the total variance can be explained by 5 factors.

Table 3. Variables belonging to the factors in the rotated factor matrix of the complete sample.

Factor	Eigenvalue	Variables
I	3.84	9, 17, 20
II	1.70	1, 5, 51, 54
III	1.64	8, 45
IV	1.49	48, 55
V	1.09	52, 66

As concerns the arrangement of variables, we consider the affinity of the variables 9, 17 and 20 loaded in the first factor to be the most important feature of this sample. Not only for its definitely high eigenvalue, but also because it is not common for one breadth and two height dimensions to be weighted into the same factor. In contrast, the connection of the variable pairs 8-45, 48-55 and 52-66 may be regarded as a general property of the human skull. The second factor is a combination of two length and two breadth dimensions.

The incomplete samples (Table 4)

Table 4. Variables belonging to the factors in the rotated factor matrices of the incomplete samples.

% of missing data	DEAR's PC method			Mean substitution			Pairwise deletion		
	Factor	Eigenvalue	Variables	Factor	Eigenvalue	Variables	Factor	Eigenvalue	Variables
10									
	I	4.19	1, 8, 45, 54	I	3.69	5, 51, 1, 9	I	3.98	8, 54, 45
	II	1.86	5, 9, 17, 20	II	1.95	8, 45, 54	II	2.07	51, 66, 52
	III	1.54	51, 52, 66	III	1.63	17, 20	III	1.68	17, 20
	IV	1.44	48, 55	IV	1.45	48, 55	IV	1.51	5, 9, 1
				V	1.04	52, 66	V	1.01	55, 48
20									
	I	4.81	51, 52, 66	I	3.75	8, 54, 45, 1	I	4.40	66, 51, 52, 9
	II	1.73	1, 5, 9, 17, 20	II	2.00	66, 51, 52, 9	II	2.18	8, 54, 45, 1
	III	1.41	8, 45, 54	III	1.62	17, 20, 5	III	1.69	17, 20, 5
	IV	1.26	48, 55	IV	1.40	48, 55	IV	1.49	48, 55
30									
	I	4.96	51, 52, 66	I	3.42	8, 45, 54, 1	I	4.27	8, 45, 54, 1
	II	1.62	1, 8, 45, 54	II	2.03	66, 51, 52	II	2.44	51, 66, 52
	III	1.35	5, 9, 17, 20	III	1.70	17, 5, 9	III	1.93	9, 5
	IV	1.30	48, 55	IV	1.35	55, 48	IV	1.53	55, 48
				V	1.01	20	V	1.07	20, 17

Variables 9, 17 and 20 remain together only if DEAR's PC method is used to replace missing values. With either mean substitution or pairwise deletion, no affinity of these three variables can be observed at all.

The connection between variables 1, 5, 51 and 54 (the second factor originally) breaks up in every case. Variable 51 tends to connect with variables 52 and 66. Variables 1 and 54 are loaded into the same factor usually.

The variable pair 8 and 45 always remain together, but with a relation to other variables in the case of analyses of incomplete samples.

The arrangement of variables 48 and 55 is stable.

It is striking that the eigenvalues of special groups of variables have changed. While the eigenvalue of the factor belonging to variables 9, 17 and 20 is the highest in the matrix of the complete data, it is considerably lower in that of the incomplete samples.

Conclusions

Of the three missing value methods used, DEAR's PC method gives the most acceptable results in a PC analysis. With this method the arrangement of variables in the rotated factor matrix proved quite correct, even in the case of 30 per cent of missing values, but the importance of the factors concluded from their eigenvalues must be treated with caution.

The other two missing value methods (mean substitution and pairwise deletion) provide acceptable results only for the variables for which a close relation is presumed to exist in each human skull, but not for the arrangement of variables presumed to be special in the sample examined.

References

CHAN, L. S. and DUNN, O. J. (1972): The Treatment of Missing Values in Discriminant Analysis-I. The Sampling Experiment. - JASA *67*, 473-477.

DEAR, E.A. (1959): Principal Component Missing Data Method for Multiple Regression Models. SD Corp. - Technical Report SP-86.

MARTIN, R. (1928): Lehrbuch der Anthropologie. - Fisher, Jena, 2 Aufl. 2. Bd.

WENGER, S. (1957): Données ostéométriques sur le matériel anthropologique du cimetière d'Alattyán-Tulát, provenant de l'époque avare. - Crania Hungarica *2*, 1-55.

ACTA BIOL. SZEGED. 42, pp. 59-65 (1997)

PALEOSOCIOLOGICAL CONCEPTS TO THE INVESTIGATION OF SOME SOCIAL PHENOMENA OF PAGAN AND CHRISTIAN PERIODS

L. HÜSE and L. SZATHMÁRY

Kossuth Lajos University, Department of Humanbiology, Debrecen, H-4010, P.O.B. 6, Hungary

(Received: December 10, 1996)

Abstract

This paper deals with methodological problems which arise during paleodemographic and paleosociological studies. The methodological principles of these two shared auxiliary sciences of archeology and anthropology were established by NEMESKÉRI, KRALOVÁNSZKY and ÉRY. The authors, apply these principles as starting point, and also make use of their own research experience and that of other colleagues, and stress the necessity for the application of new methods.

Methodological questions are discussed here on the basis of the 10th-11th century cemetery at Püspökladány-Eperjesvölgy as an example. This cemetery, highly representative from many points of view, provides an excellent basis for model investigations.

Key words: paleodemography, paleosociology, 10th-11th centuries, Hungarians, cemetery at Püspökladány-Eperjesvölgy.

Introduction

Paleodemography is an auxiliary science shared by archeology and anthropology, the main aim of which is to study demographic characteristics of ancient populations. It may also contribute to the outline of social structure, especially if study of the biological characteristics of ancient populations includes a special area of material culture, grave contents. Paleodemographic studies have three main phases. In the first phase, the excaved osteological material is assessed by means of anthropological methods. In the second phase, after quantification, the data are subjected to statistical analysis. On the basis of the ages at death and sex, mortality charts of the populations are prepared separately for the overall population and for both males and females considered to be adults from an osteological aspect. The third phase of the research involves the study of material culture relics, according to the demographic characteristics of the population, also called historical sociology or paleosociology. Paleosociology may be regarded as a discipline independent of paleodemography, but it should not be forgotten that the only possibility for a realistic evaluation of material culture relics is their analysis, on the basis of demographic statistics. Only this method can guarantee that the analysis provides a reliable picture not only of the „rich" or „poor" character of the cemetery in question, but also of the ancient society.

Results and Dicussion

The 10th-11th century cemetery at Püspökladány-Eperjesvölgy was used as an example to illustrate problems related to the methods of paleodemographic studies, and to present the methodological solutions suggested for introduction. The cemetery is extremely populous, being 5-10 times larger than other excavated cemeteries from the same period. In addition, due to the favourable soil conditions, the skeletons are well preserved, the majority of them being suitable for anthropological analysis. From the 601 assessable skeletons unearthed in the excavations by M. NEPPER between 1977 and 1982, 230 individuals may date from the 10th century and 371 from the 11th century (M. NEPPER, manuscript).

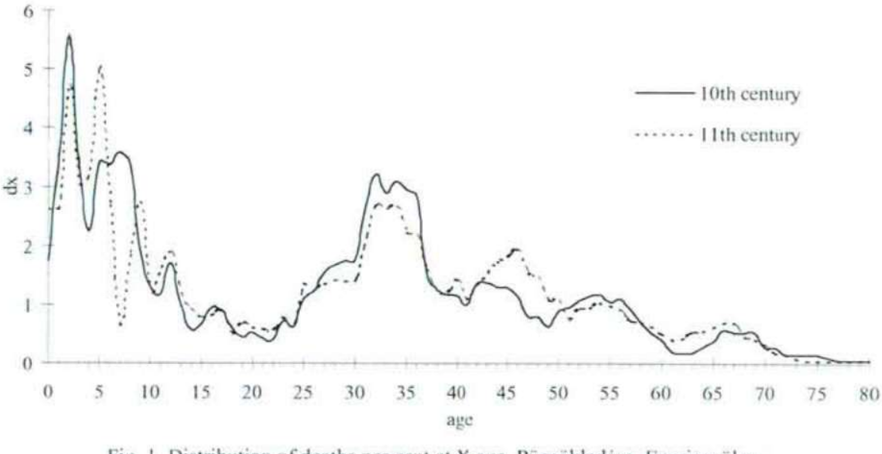

Fig. 1. Distribution of deaths per cent at X age. Püspökladány-Eperjesvölgy.

Anthropological studies on the population of the Püspökladány-Eperjesvölgy cemetery were made by the following methods: for subadult individuals, the age of death was determined according to the concepts of SCHOUR and MASSLER (1940) and JOHNSTON (1961); for the adults, the method of ACSÁDI and NEMESKÉRI (1970) was used; the same method was used for sex determination. The mortality charts contain the following data: age = X; distribution of deaths, no. at age X = Dx; distribution of deaths, percentage at age X = dx; distribution of surviving individuals, percentage at the beginning of age X = lx; probability of death at age X = qx; life expectancy at age X = ex0. These charts were prepared for both centuries separately, on the basis of the data relating to the overall population, the adult males and the adult females (Figs 1 and 2).

The archeological material was studied according to three main groups of objects: I. everyday artifacts and weapons; II. clothing objects; III. ritual objects. This divison corresponds to the usual classification of archeological material, though at the same time raises certain questions. One is whether it is reasonable to consider everyday artifacts and weapons from the Pagan period strictly according to their instrumental nature. Considering Pagan beliefs concerning the other world, after the burial these objects lose their instrumental purpose and acquire a religious character, serving to supply the dead in the other world, thereby becoming objects which definitely belong in the category of „ritual objects" (Figs 3 and 4).

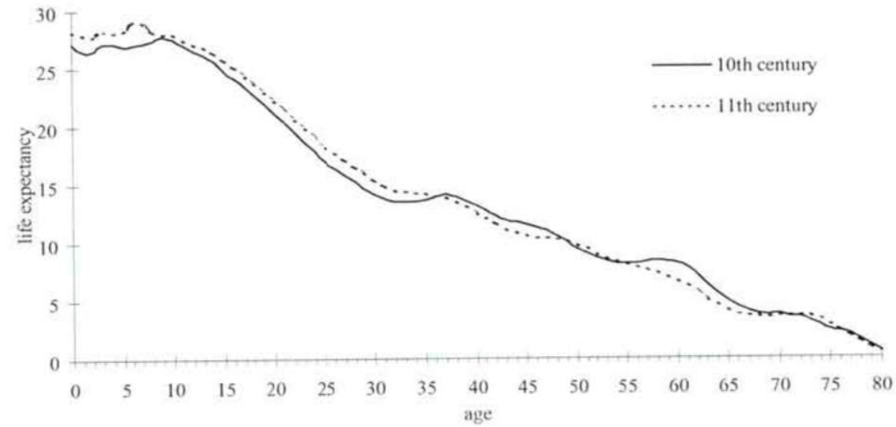

Fig. 2. Life expectancy at X age. Püspökladány-Eperjesvölgy.

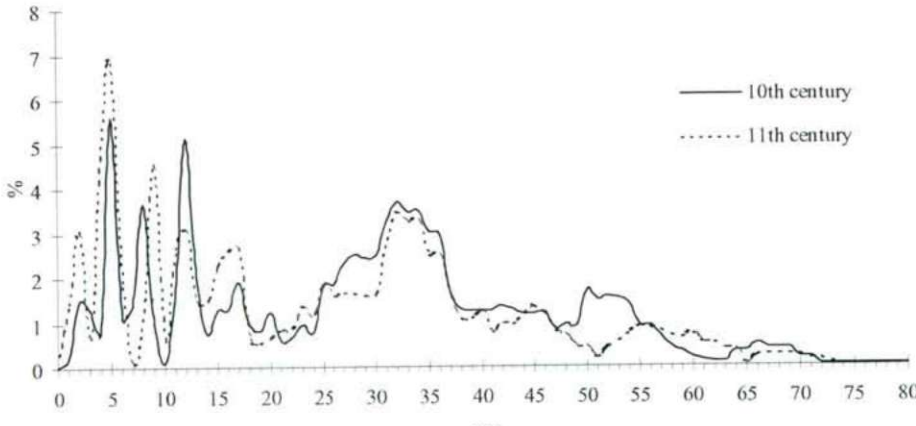

Fig. 3. Ratio of grave goods. Püspökladány-Eperjesvölgy.

When a classification of grave contents is prepared, consideration must be given to the length of the period studied and the nature of the changes which took place in beliefs and ideology during the period in question. In the present example, social customs of the Pagan period and of the beginning of the Christian era appear to be intermingled within the same cemetery. If we consider the buried artifacts and weapons of the Pagan period (which serve to supply the dead in the other world) as belonging among ritual objects (by which devotion toward a deity is manifested), this is probably do not a misinterpretation, yet in this case the process of changing might be lost, i.e. the significant change which can be observed in the group of objects in question during the change to Christianity (Fig. 5).

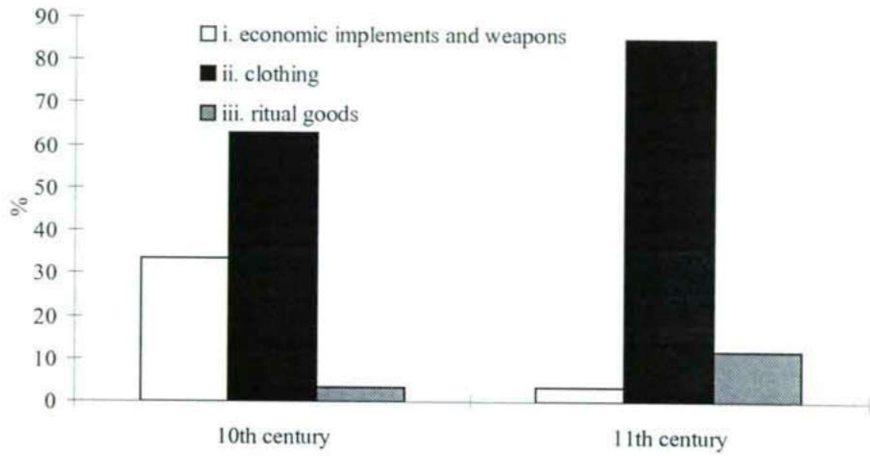

Fig. 4. Percentual distribution of grave goods by groups of objects. Püspökladány-Eperjesvölgy.

Fig. 5. The distribution of grave goods in subadult and adult female and male cohortes by groups of objects. Püspökladány-Eperjesvölgy.

The second problem is related to the interpretation of the quantity of items found within a grave. To what degree can the number of grave contents reflect the social status or the richness of the deceased?

We believe that this question can be answered at the microlevel (individual level), while a complete paleodemographic analysis may reveal processes at the macrolevel (the level of the overall society or a group level). Confusion of these two levels may lead to errors (MOKSONY, 1985). At the same time, if it is accepted that those who live at a lower social level (i.e: the poor) have worse chances in life, we can justifiably search for manifestations within ancient populations, too. We consider that the poor within ancient populations are represented by burials without grave goods.

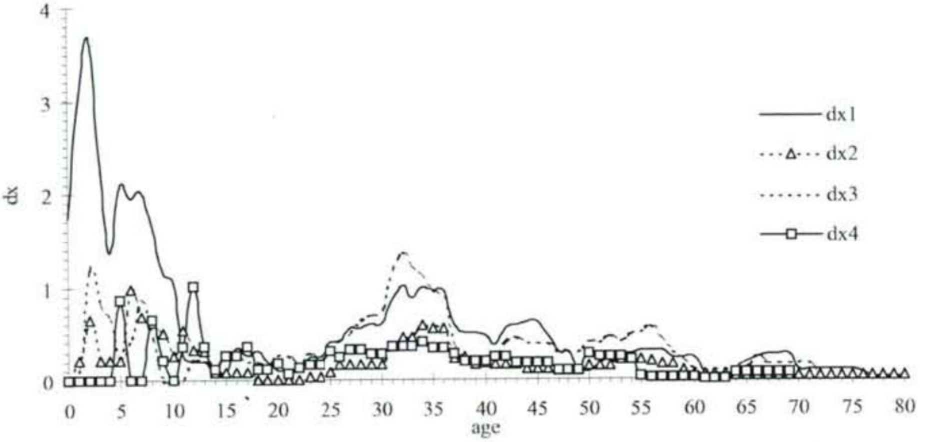

Fig.6. Mortality rates within groups established according to the number of grave goods (10th century). Püspökladány-Eperjesvölgy.

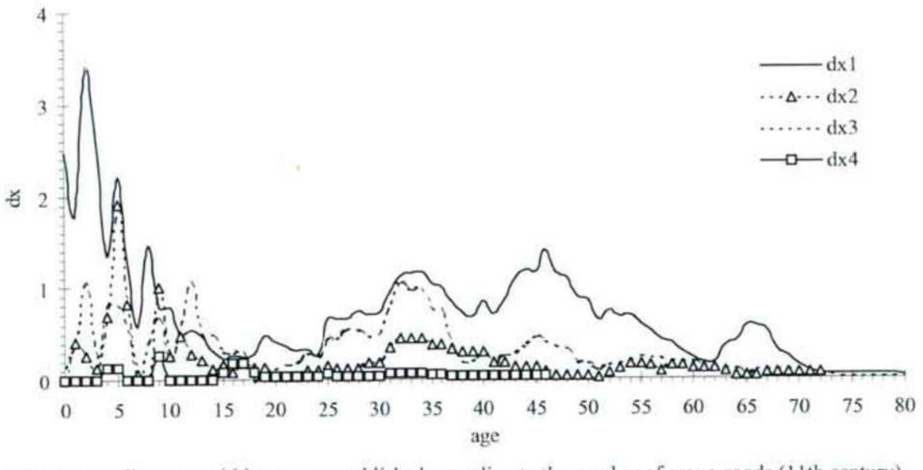

Fig. 7. Mortality rates within groups established according to the number of grave goods (11th century). Püspökladány-Eperjesvölgy.

As an experiment, we divided the 10th and 11th century populations of Püspökladány-Eperjesvölgy into four groups, according to the number of grave goods: 1 - without grave goods; 2 - with a single item; 3 - with 2-5 items; 4 - with more than 6 grave items. Within each group, we calculated the percentage distribution of deaths (dx) for every age group and compared them with each other. It became clear that, whereas the three groups supplied with grave goods do not differ from each other, the group without grave goods exhibits a higher mortality rate in comparison with all the other groups (with grave goods). We do not consider the result of this experiment to be really surprising; nevertheless, it confirmed the valid of our supposition. The study of grave goods may make a marked contribution to the analysis of Medieval society (Figs 6 and 7).

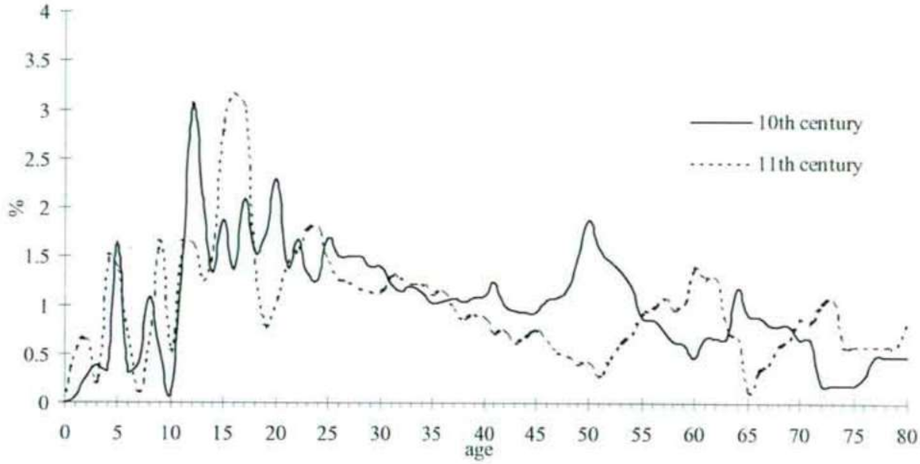

Fig. 8. Modified distribution of grave goods if the distribution of deaths per cent is 1.00 in every age group. Püspökladány-Eperjesvölgy.

The graph of the percentage distribution of deaths (dx) by age groups is markedly similar to that of the percentage distribution of grave goods by age groups. The latter graph demonstrates that grave goods appear most frequently in the graves of those who died between the ages of 3 and 18 years and between 30 and 40 years of age. The percentage distribution of deaths within these cohorts is similarly the highest. This suggests that the number of grave goods may not reflect the social prestige in the cohorts in question, but rather the higher mortality rate in these cohorts. Therefore, within each group we modified dx to 1.00 and the number of excavated grave goods was compared with this. The graph prepared on this basis shows the cohort of young adults (those at the beginning of self-reliant life, but dying between the ages of 16 and 25 years) to be the group primarily supplied with grave goods. This appear to be the group with the highest social prestige in the 10th-11th century Hungarian society (Fig. 8).

Conclusions

In paleodemographic studies on material from the 10th-11th century cemetery at Püspökladány-Eperjesvölgy, the sociological relations of this ancient population were investigated via the grave goods from the cemetery. The main findings of the study were as follows:

1. The above classification of grave goods is considered reasonable, and these groups appear to be suitable for study of the cultural-religious conditions of the Pagan period.

2. That the poor layers of the populations had less chances in their lives in the 10th and 11th centuries. Burials without grave goods are considered to be a paleosociological criterion of poverty. The mortality rate was higher among those buried without grave goods.

3. The group of young adults at the beginning of self-reliant life appeared to enjoy the highest social prestige.

References

ACSÁDI, Gy. and NEMESKÉRI, J. (1970): History of human life span and mortality. - Akad. Kiad. Bp.

JOHNSTON, F. E. (1961): Sequence of epiphyseal union in a prehistoric Kentucky population from Indian Knoll. - Hum. Biol. *33*, 66-81.

NEMESKÉRI, J., HARSÁNYI, L. and ACSÁDI, Gy. (1960): Methoden zur Diagnose des lebensalter von Skelettfunden. - Anthrop. Anz. *24*, 70-95.

M. NEPPER, I.: Régészeti jelentés az OTKA 5151 számú pályázat részére. - Déry Múzeum, Debrecen, (manuscript).

MOKSONY, F. (1985): A kontextuális elemzés. - KSH Népességtudományi Kutató Intézet Demográfiai Módszertani Füzetek. Bp.

SCHOUR, J. and MASSLER, M. (1940): Studies in tooth Development: The growth pattern of Human teeth. - J. Amer. Dent. Ass. 28, 1778-1793; 1918-1931.

ACTA BIOL. SZEGED. 42, pp. 67-73 (1997)

PALEODEMOGRAPHY AND POPULATION BIOLOGY STUDIES RELATING TO THE MARVELE BURIAL GROUND (2nd - 7th CENTURIES AD)

R. JANKAUSKAS and A. URBANAVIČIUS

Department of Anatomy, Histology and Anthropology, Faculty of Medicine, University of Vilnius, Čiurlionio 21, Vilnius LT2009, Lithuania.

(Received: December 30, 1996)

Abstract

Paleodemographic analysis was performed in connection with the Marvele burial ground (the largest from the 1st millennium AD) in Central Lithuania, in a search for peculiarities in population biological status in three time periods (OIA2 - 150-300 AD, OIA3 - 300-450 AD and MIA - 450-600 AD). Certain parallels were found between cultural orientation and demographic indices. In the earliest phase, the population of Marvele was the largest, and grave inventories indicated that it had close connections with its southern neighbours. In the next phase, there were definite declines in population number and indices of fertility and mortality; an intensification of contacts with Eastern Balts was characteristic for the period. In the latest phase of inhumations, the demographic indices were improved, but mainly due to the rise in male life expectancy; for this period, the immigration of Eastern Balts took place, as suggested by demographic structure of the population.

Key words: Paleodemography, Iron Age, Lithuania.

Introduction

On the amber coast, at the north-east end of the known world, Tacitus localized mysterious people, *Aestiorum gentes*. He attributed this population to the great community of barbaric tribes, *Germania libera*, though he clearly distinguished the *Aestii* on the basis of their non-Germanic language. This area was of interest to the Roman empire as a source of amber, and regular trade routes were established between the Roman provinces in Central Europe and the South-East Baltic area. Although the main interests of the Romans were concentrated on Semba peninsula (today's Kaliningrad district), as the principal source of amber, regions to the east were of importance as the deep hinterland of the amber trade route (NOWAKOWSKI, 1996).

Archaeological investigations at the Marvele burial ground, located in Central Lithuania, in the territory of today's Kaunas city, were started in 1991 by the Department of Archaeology, University of Vilnius (contractors A. ASTRAUSKAS and M. BERTAŠIUS). Over 1,000 graves have so far been unearthed, making this burial ground the largest cemetery of the period, extending over a 1,000-year time span (from the 2nd to the 11th-12th centuries). Such a large complex with broad chronology affords a unique possibility to trace cultural and biological processes over a lenghty period.

The Marvele burial ground embraces the Old Iron Age (OIA) or Roman period (1st-4th centuries), the Middle Iron Age (MIA) or Migration period (5th-7th centuries), and the Late Iron Age (LIA) or Early Medieval period. In the OIA, people of several Baltic cultures inhabited Lithuania, one of these being the Central Lithuanian Flat Burial Culture. In general, the cultures of the area were distinct from those of the Roman provinces and the barbaric 'intermediates' of the amber route, and survived periods of rise and decline. They were never isolated from the surrounding world, experiencing feedback interactions with others. During the earliest period, OIA1 (B1-C1a, 70-220 AD), complex burial goods characteristic of the West Balts in general prevailed (Astrauskas, 1996). By the end of this period, new types of artifacts had appeared, and most older cemeteries had been abandoned. In the next period, OIA2 (C1a-C2, 150-300 AD), certain cultural changes took place, as new cemeteries, Marvele among them, were established, and neighbouring.southern regions such as Mozuria and Sudovia strongly influenced the material culture. During the following period, OIA3 (C3-D, 300-450 AD), contacts with East Lithuania intensified, as indicated by new artifacts as well as slightly different funerary traditions. The fourth stage of inhumations corresponded to MIA (E, 450-600 AD) and reflected absolutely different cultural and social realities; it was marked by a new complex of artifacts, and by wealthy burials containing silver implements (ASTRAUSKAS, 1996). These changes had to be related to, general processes throughout Europe, the growth of the influence of the Ostrogothic state in Pontic region and the conquests of the Huns (ŠIMENAS, 1992). Craniological data reveal that distinct biological changes took place in parallel with the cultural shift: hypermorphic dolichocranic people with high narrow faces were replaced by an extremely hypermorphic dolichocranic population with high broad faces (ČESNYS, 1990), a more robust skeleton and a taller stature (JANKAUSKAS and BARKUS, 1994). The LIA period in the Marvele burial ground, as in Lithuania in general, was characterized by the spread of cremation customs, often associated with nearby ritual horse burials, and the intensification of peri-Baltic trade connections, especially with Scandinavia (BERTAŠIUS, 1996).

The purpose the of present paper is to discuss possible anthropological (cultural and physical) parallels of this burial ground, to examine whether there was any basis explainable in biological terms for the cultural changes in Marvele. The discussion will be limited to paleodemographic and some paleopathologic data, as traditional craniometric and odontologic traits systems, though provisionally discussed elsewhere (JANKAUSKAS and BARKUS, 1996), should be revised and updated.

Materials and methods

To date, only skeletal materials of inhumations (OIA and MIA) have been investigated. The majority of the bones were extremely badly preserved, due to the unfavourable soil conditions. The sex and age of each individual were estimated by using conventional methods (SZILVASSY, 1988; SJØVOLD, 1988; GARMUS and JANKAUSKAS, 1993). In total, sex and/or age were estimated for 514 individuals. Ordinary life tables (ACSÁDI and NEMESKÉRI, 1970; UBELAKER, 1989) were calculated for three chronological periods (OIA2, OIA3 and MIA).

Results and discussion

Life tables for each chronological time period are presented in Table 1 (total subsamples), Table 2 (males) and Table 3 (females).

Table 1. Life tables of subadults and adults from three Marvele burial ground chronological periods.

x	D_x	d_x	l_x	q_x	L_x	T_x	e^0_x
Old Iron Age 2 (150-300 AD)							
0	15	5.64	100.00	0.06	97.18	2723.12	27.23
1-4	32	12.03	94.36	0.13	441.73	2625.94	27.83
5-9	24	9.02	82.33	0.11	389.10	2184.21	26.53
10-14	12	4.51	73.31	0.06	355.26	1795.11	24.49
15-19	8	3.01	68.80	0.04	336.47	1439.85	20.93
20-29	46.5	17.48	65.79	0.27	570.49	1103.38	16.77
30-39	67	25.19	48.31	0.52	357.14	532.89	11.03
40-49	45.5	17.11	23.12	0.74	145.68	175.75	7.60
50+	16	6.02	6.02	1.00	30.08	30.08	5.00
Total	266	100.00		2723.12			
Old Iron Age 3 (300-450 AD)							
0	14	10.85	100.00	0.11	94.57	2411.43	24.11
1-4	17	13.18	9.15	0.15	412.79	2316.86	25.99
5-9	16	12.40	75.97	0.16	348.84	1904.07	25.06
10-14	6	4.65	63.57	0.07	306.20	1555.23	24.47
15-19	2.5	1.94	58.91	0.03	289.73	1249.03	21.20
20-29	23	17.83	56.98	0.31	480.62	959.30	16.84
30-39	23	17.83	39.15	0.46	302.33	478.68	12.23
40-49	18.5	14.34	21.32	0.67	141.47	176.36	8.27
50+	9	6.98	6.98	1.00	34.88	34.88	5.00
Total	129	100.00		2411.43			
Middle Iron Age (450-600 AD)							
0	1	0.84	100.00	0.01	99.58	2942.68	29.43
1-4	9	7.53	99.16	0.08	476.99	2843.10	28.67
5-9	16	13.39	91.63	0.15	424.69	2366.11	25.82
10-14	6	5.02	78.24	0.06	378.66	1941.42	24.81
15-19	3	2.51	73.22	0.03	359.83	1562.76	21.34
20-29	23	19.25	70.71	0.27	610.88	1202.93	17.01
30-39	28.5	23.85	51.46	0.46	395.40	592.05	11.50
40-49	26	21.76	27.62	0.79	167.36	196.65	7.12
50+	7	5.86	5.86	1.00	29.29	29.29	5.00
Total	119.5	100.00		2942.68			

The survivorship rate (l_x) and, correspondingly, the probability of death (q_x) for all subsamples shows that the mortality and probability of death in young age groups were highest in OIA3, i.e. higher than in the earlier period (OIA2) and substantially higher than in the later MIA stage. For adult males, the same regularities were established, but for females, quite unexpectedly, a more complicated situation was found: female mortality at a young (reproductive) age was highest in MIA, exceeding that in OIA2 and even OIA3. As a result, the average life expectancy fluctuated for pooled samples (a decrease in e^0_0 from OIA2 to OIA3, and a substantial increase from OIA3 to MIA), but male and female subsamples exhibited opposite tendencies: the male e^0_{20} rose slightly during all chronological periods, whereas the female e^0_{20} decreased. As a result, sex differences in life expectancy increased from 2.13 years in OIA2 to 6.53 years in MIA.

Table 2. Life tables of adult males from three Marvele burial ground chronological periods.

x	D_x	d_x	l_x	q_x	L_x	T_x	e^0_x
Old Iron Age 2 (150-300 AD)							
20-24	6	6.67	100.00	0.07	483.33	1783.33	17.83
25-29	12	13.33	93.33	0.14	433.33	1300.00	13.93
30-34	14	15.56	80.00	0.19	361.11	866.67	10.83
35-39	19	21.11	64.44	0.33	269.44	505.56	7.84
40-44	25	27.78	43.33	0.64	147.22	236.11	5.45
45-49	7	7.78	15.56	0.50	58.33	88.89	5.71
50-54	5	5.56	7.78	0.71	25.00	30.56	3.93
55+	2	2.22	2.22	1.00	5.56	5.56	2.50
Total	90	100.00		1783.33			
Old Iron Age 3 (300-450 AD)							
20-24	6	14.29	100.00	0.14	464.29	1785.71	17.86
25-29	6	14.29	85.71	0.17	392.86	1321.43	15.42
30-34	6	14.29	71.43	0.20	321.43	928.57	13.00
35-39	3	7.14	57.14	0.13	267.86	607.14	10.63
40-44	9	21.43	50.00	0.43	196.43	339.29	6.79
45-49	6	14.29	28.57	0.50	107.14	142.86	5.00
50-54	6	14.29	14.29	1.00	35.71	35.71	2.50
55+	0	0.00	0.00	0.00	0.00	0.00	0.00
Total	42	100.00		1785.71			
Middle Iron Age (450-600 AD)							
20-24	2	4.26	100.00	.04	489.36	1994.68	19.95
25-29	5	10.64	95.74	0.11	452.13	1505.32	15.72
30-34	6	12.77	85.11	0.15	393.62	1053.19	12.38
35-39	9	19.15	72.34	0.26	313.83	659.57	9.12
40-44	11	23.40	53.19	0.44	207.45	345.74	6.50
45-49	9	19.15	29.79	0.64	101.06	138.30	4.64
50-54	4	8.51	10.64	0.80	31.91	37.23	3.50
55+	1	2.13	2.13	1.00	5.32	5.32	2.50
Total	47	100.00		1994.68			

An analysis of 'synthetic' demographic indices (Table 4) provides a possibility for a clearer insight into the processes taking place in the Marvele burial ground during three chronological periods of inhumations. First of all, a substantial increase in crude mortality in OIA3 is evident. As a consequence, although the potential reproductive rate remained high, the proportion of children dying in the pre-reproductive age was also extremely high (41.1%), the population reproduction decreased, and the population size could be estimated as being twice as small as in the previous period. In other terms, we have evidence of a certain demographic crisis. The principal fertility and mortality indices started to improve only in MIA: the mortality rate decreased (mostly due to the higher life expectancy in males), and the population reproduction rate rose.

Table 3. Life tables of adult females from three Marvele burial ground chronological periods.

x	D_x	d_x	l_x	q_x	L_x	T_x	e^0_x
Old Iron Age 2 (150-300 AD)							
20-24	7	8.14	100.00	0.08	479.65	1569.77	15.70
25-29	21	24.42	91.86	0.27	398.26	1090.12	11.87
30-34	21	24.42	67.44	0.36	276.16	691.86	10.26
35-39	12	13.95	43.02	0.32	180.23	415.70	9.66
40-44	8	9.30	29.07	0.32	122.09	235.47	8.10
45-49	8	9.30	19.77	0.47	75.58	113.37	5.74
50-54	7	8.14	10.47	0.78	31.98	37.79	3.61
55+	2	2.33	2.33	1.00	5.81	5.81	2.50
Total	86	100.00		1569.77			
Old Iron Age 3 (300-450 AD)							
20-24	5	14.29	100.00	0.14	464.29	1478.57	14.79
25-29	9	25.71	85.71	0.30	364.29	1014.29	11.83
30-34	7	20.00	60.00	0.33	250.00	650.00	10.83
35-39	4	11.43	40.00	0.29	171.43	400.00	10.00
40-44	4	11.43	28.57	0.40	114.29	228.57	8.00
45-49	2	5.71	17.14	0.33	71.43	114.29	6.67
50-54	3	8.57	11.43	0.75	35.71	42.86	3.75
55+	1	2.86	2.86	1.00	7.14	7.14	2.50
Total	35	100.00		1478.57			
Middle Iron Age (450-600 AD)							
20-24	7	18.42	100.00	0.18	453.95	1342.11	13.42
25-29	7	18.42	81.58	0.23	361.84	888.16	10.89
30-34	11	28.95	63.16	0.46	243.42	526.32	8.33
35-39	5	13.16	34.21	0.38	138.16	282.89	8.27
40-44	4	10.53	21.05	0.50	78.95	144.74	6.88
45-49	2	5.26	10.53	0.50	39.47	65.79	6.25
50-54	1	2.63	5.26	0.50	19.74	26.32	5.00
55+	1	2.63	2.63	1.00	6.58	6.58	2.50
Total	38	100.00		1342.11			

The above demographic data allow the hypothesis of archaeological and biological parallels. Diminishing contacts with southern regions and the intensification of the Eastern influence in OIA3 were followed by a decrease in population number. This could suggest the importance of southern neighbours as trade mediators in maintaining Marvele as a local trade centre. In MIA, this weakened centre received a 'second breath', but, due to the mechanical immigration of new people from the East, areas traditionally inhabited by the Eastern Balts, as all archaeological and anthropological data show. This cultural and biological change was gradual, as inhumation tradition in the same burial ground continued, although not always smoothly and peacefully: archaeological data suggest the robbery of OIA3 graves (ASTRAUSKAS, personal comm.). Thus, although culturally related, these newcomers were distinct biologically - they were phenotypically related to other MIA hyperrobust populations. Moreover, some paleopathological data suggest genetic relations (the incidence of ankylosing spondylitis, a disease with a certain genetic predisposition, non-existent in OIA, was surprisingly high in some MIA Central Lithuanian populations, Marvele being no exception - 5 cases of MARIE-STRÜMPEL-BECHTEREW disease were identified, all from MIA).

In this way, some parallels were established between cultural and biological data in one Central Lithuanian 1st millennium burial ground. A discussion of the causes (did cultural changes precede demographic shifts or vice versa?) must remain for the future.

Table 4. Calculated demographic indices of three chronological periods in the Marvele burial ground.

Index	OIA2	IA3	MIA
Crude mortality rate, M	36.72	41.48	33.98
Potential gross reproductive rate, R_{pot}[1]	0.793	0.803	0.787
Net reproduction rate, R_0[1]:			
If Uc = 6	1.637	1.419	1.728
If Uc = 8	2.182	1.892	2.304
Population size[2]	63.29	35.13	38.45
Population size[3]	48.29	20.73	23.45

[1] HENNEBERG, 1976
[2] ACSÁDI and NEMESKÉRI, 1970
[3] UBELAKER, 1989
Note: U_c = completed fertility (cumulative number of births per woman surviving the reproductive period).

Acknowledgements

We wish to thank archaeologists A. ASTRAUSKAS and M. BERTAŠIUS for their thorough field work involving the collection and transportation of skeletal materials, and for valuable discussions and suggestions.

References

ACSÁDI, Gy. and NEMESKÉRI, J. (1970): History of human life span and mortality. - Akadémiai Kiadó, Budapest.

ASTRAUSKAS, A. (1996): Vidurio Lietuvos gyventoju kulturines orientacijos kaita SGA-VIGA. In: ASTRAUSKAS, A. and BERTAŠIUS, M. (eds): Vidurio Lietuvos archaeologija: etnokulturiniai ryšiai. - Vilnius, 4-10 pp.

BERTAŠIUS, M. (1996): Vidurio Lietuva: Rytu prekybos kelio beieškant. In: ASTRAUSKAS, A. and BERTAŠIUS, M. (eds): Vidurio Lietuvos archaeologija: etnokulturiniai ryšiai. - Vilnius, 11-17 pp.

ČESNYS, G. (1990): Lietuviu etnines paleoantropologijos pagrindai. - Vilniaus un-to l-kla.

GARMUS, A. and JANKAUSKAS, R. (1993): Methods of person's identification from the skeleton in Lithuania. - Medicina Legalis Baltica *3-4*, 5-21.

HENNEBERG, M. (1976): Reproductive possibilities and estimations of the biological dynamics in earlier human populations. In: WARD, R. H. and WEISS, K. M. (eds): The demographic evolution of human populations. - Academic Press, 41-48 pp.

JANKAUSKAS, R. and BARKUS A. (1994): Marveles senkapio (I-VII m.e.a.) antropologija (1991-1992 m. medžiaga). In: ASTRAUSKAS, A. (Ed.): Vidurio Lietuvoa archaeologija: Konferencijos medžiaga. - Vilnius, 79-85 pp.

JANKAUSKAS, R. and BARKUS, A. (1996): Senojo ir viduriniojo geležies amžiaus Šiaurinio Suduvos paribio antropologija Marveles senkapio duomenimis. - Liaudies kultura *3* (48), 9-11.

NOWAKOWSKI, W. (1996): Römen - Barbaren - Vermittler. In: ASTRAUSKAS, A. and BERTAŠIUS, M. (eds): Vidurio Lietuvos archaeologija: etnokulturiniai ryšiai. - Vilnius, 72-79 pp.

ŠIMENAS, V. (1992): Nauji V a. pab. - VI a. pr. laidojimo paproèiai Nemuno žemupyje. In: Ikikrikščioniškosios Lietuvos kultura: Istoriniai ir teoriniai aspektai. - Vilnius, 23-35 pp.

SJØVOLD, T. (1988): Geschlechtsdiagnose am Skelett. In: KNUSSMAN, R. (ed.): Anthropologie: Handbuch der vergleichenden Biologie des Menschen. 1. - Gustav Fischer Verlag, Stuttgart, 444-480 pp.

SZILVÁSSY, J. (1988): Altersdiagnose am Skelett. In: KNUSSMAN, R. (ed.): Anthropologie: Handbuch der vergleichenden Biologie des Menschen. 1. - Gustav Fischer Verlag, Stuttgart, 421-443 pp.

UBELAKER, D. (1989): Human skeletal remains; excavation, analysis, interpretation. 2nd ed. - Smithsonian Institution: Manuals on archeology 2, Washington.

ACTA BIOL. SZEGED. 42, pp. 75-80 (1997)

THE ANTIQUITY OF OSTEOPOROSIS

L. JÓZSA

Department of Morphology, National Institute of Traumatology, H-1430 Budapest, P.O.B. 21, Hungary.

(Received: December 10, 1996)

Abstract

Osteoporosis has its origins in antiquity. Age-related bone loss has been observed in archaic and Medieval skeletons (especially females). Osteoporosis was a rare alteration before the 19th century. The consequences of osteoporosis (proximal femur end fractures, radius fractures and vertebral fractures) are very rare both in mummies and in archaic skeletal material.

Key words: osteoporosis, osteoporotic fractures, incidence, mummies, skeletons.

Introduction

The term osteoporosis was employed by pathologists in the mid-19th century and was clearly distinguished from osteomalacia. But does this mean that osteoporosis did not exist before? Paleopathologic examinations of ancient skeletons seem to indicate that osteoporotic fractures (vertebral fractures, femur proximal end fractures, etc.) were very rare.

We cannot assess the exact incidence or the age of development of osteoporosis by looking into the past. The aim of this brief overview is to ascertain whether osteoporosis has existed for centuries or millennia.

In osteoporosis research, bone density can be determined accurately and precisely by a large variety of methods, including qualitative and quantitative radiography (roentgenological examination, CT scan, ultrasound scan, etc.), densitometry (single photon absorptiometry=SPA, dual photon absorptiometry=DPA, and dual energy X-ray absorptiometry=DXA), histomorphometry and biochemical assessments. The most frequent methods in paleopathology are radiography and histomorphometry. In addition to measurements of bone mineral content and trabecular bone density, the determination of true bone geometry and architecture should be included in paleopathologic studies.

Prehistoric times

The postcranial bone remains of early hominids are extremely rare (for example: *Homo habilis* 14 limbs, WOOD, 1992). This small material is completely insufficient for an estimation of the occurrence of osteoporosis, but the radiological examinations of the Australopithecinae show no structural alterations in the bones (LEAKEY et al., 1995; SUSMAN, 1994).

The Neanderthals lived between 100,000 and 35,000 BP in Europe and Western Asia. Their limb bones differed from those of modern humans only in their tendency to be more robust. The cortical thickness of Neanderthal bones was 1.5 to 2.0 times greater (especially in the bones of the lower limbs) than in recent human samples. In addition, the trabecular bone density of the Neanderthals was higher than that of modern humans. The robusticity index of the Neanderthals was 30 to 60% greater in all bones of the lower limbs than in modern humans. We know of no signs of osteoporosis described for the Neanderthals (TRINKAUS, 1983; TRINKAUS and HOWELLS, 1979; TRINKAUS and ZIMMERMAN, 1982).

KNEISSEL et al. (1994) studied cancellous bone changes in 18 individuals from the early Bronze Age (4000 BP) from Lower Austria. They demonstrated that the loss of quantity in the cancellous bone occurred in females between the ages of 40 and 60 years. In contrast, BELL et al. (1996) found no age or sex differences in the amounts of cortical bones in archeological material. FRIGO et al. (1996) found differences in bone density between women and men in the early Bronze Age (4200-3600 BP).

Osteoporosis in historic times

The radiological and DPX examinations by EKENMAN et al. (1995) revealed a higher bone density in the lower extremities in a population from 1300-1530 AD from Stockholm than in modern humans. There was no decrease in bone density in the older group as compared to the younger. LEES et al. (1993 and 1995) found no significant bone loss in women over a period of two centuries, whereas marked gender differences were detected by DXA.

We have made a radiologic examination of 341 adult skeletons from the 10th-12th centuries. The frequency of vertebral and femoral osteoporosis was 7.0% among men over 61 years, and 16.6% among senile females (JÓZSA and PAP, 1996). No osteoporotic fractures were found in the vertebras, femora, tibias and pelvic bones. FARKAS et al. (1993) found only one case of osteoporosis among 294 adult skeletons from the 10th-12th centuries. LUZSA et al. (1988) radiographically detected only one case of osteoporosis, in a 39-year-old female, among 15 Hungarian royal skeletons. Among the Medieval Hungarian population, the incidence of osteoporosis was very low and osteoporotic fractures were extremely rare (FARKAS et al., 1993; JÓZSA, 1996; JÓZSA and PAP, 1996; LUZSA, 1988; PAP and SUSA, 1986; etc.). In the Hungarian paleopathological literature, MOLNÁR et al. (1996) first described one case of cervical and one case of intertrochanteric fracture and severe osteoporosis in senile females, among 286 skeletons from the 10th-12th centuries. We have determined the bone mineral content and bone mineral density by SPA on 110 radius samples from the 10th-12th centuries. No progressive osteoporosis was found in this material (DÓCZI et al., in preparation). The osteodensity and bone mineral content were higher in all age groups in Medieval bones than in modern humans.

REIMERS et al. (1988) histometrically determined the trabecular bone mass of 65 skeletons of nonsenile prehispanic (before 1495) inhabitants of Grand Canaria. The authors found that 29% of the prehispanic population of Grand Canaria had osteoporosis. BURR et al. (1990) reported that the osteonal wall thickness and the dimensions of the osteons did not change with age in prehistoric Pecos Indians. In contrast, GUNNES-HEY (1985) found age-related cortical bone loss among prehistoric Koniag Eskimos. PFEIFFER and KING (1983) demonstrated a strong dependency between diet and cortical bone mass among prehistoric Iroquoians. It is well confirmed that the bone mass loss increases with age in prehistoric populations, but this does not necessarily mean osteoporosis (BEAR et al., 1990; ERICKSEN, 1976; GUNNES-HEY, 1985; VAN-GREVEN et al., 1969).

In some bone pathologies, such as infection, rheumatic diseases and malignant tumors, severe osteoporosis could not be detected in skeletons (GUNNES-HEY, 1980; KRAMAR et al., 1990; LESTER and SHAPIRO, 1968; THOULD and THOULD, 1983; WELLS, 1962, 1963; etc.). However, severe osteoporosis was found in the skeleton of a young female displaying premature senescence (HAHN and CZARNETZKI, 1980).

In summary: the data in the anthropological and paleopathological literature suggest that osteoporosis and especially its consequences (i.e. osteoporotic fractures) were rare before the 19th century.

Osteoporotic fractures

The literature (JÓZSA et al., 1996) details the autopsy protocols (ALDRED and SANDISON, 1962; BORN, 1959; BOURKE et al., 1971; BROTHWELL et al., 1969; COCKBURN et al., 1975; ELLIOT-SMITH and DAWSON, 1924; EL-NAJJAR et al., 1980; HENN, 1993; JÓZSA et al., 1996; KUO-LIANG et al., 1982; LEWIN, 1991; MOODIE, 1931; RUFFER, 1921; SHAW, 1938; SMITH, 1908; WALDRON, 1990; WEI, 1973; WILLIAMS, 1927; WOOD-JONES, 1908; WU, 1981), and roentgenographic, CT and magnetic resonance examinations on more than 3000 Egyptian, Chinese, South-American, Eskimo, Aleutian, Canarian and European mummies (AHLSTRÖM et al., 1978; BRAUNSTEIN et al., 1988; ENDES and VARGHA, 1988; GRAY, 1967, 1973; HARRIS and WENTE, 1980; HODLER et al., 1990; HÜBENER and PAHL, 1981; LEWIN, 1978; LEWIN et al., 1990; MARX and D'AURIA, 1988; MOODIE, 1931; PIEPERBRINK et al., 1986). No osteoporosis or osteoporotic fractures were mentioned among the South-American, Aleutian, Eskimo, Canarian, Chinese and European mummies. Among the Egyptian mummies (over 1800 cases) 6 cases of cervical and 2 cases of intertrochanteric femur fractures were detected, and in addition one case of pathological fracture of trochanteric region due to malignancy. In the literature, we found no osteoporotic (distal) radius fracture and few vertebral fractures.

In skeletal material, PALES (1930) first reported one cervical and two intertrochanteric fractures from the late Roman period. Later, about 20 cases of fractures of the proximal femur end were described (BENNIKE et al., 1985; BERG, 1972; HAMADA and RIDA, 1972; HUSSEIN, 1950; JÓZSA et al., 1996; MOLNÁR et al., 1996; WELLS, 1964).

The paleopathological, paleoradiological and paleohistological examinations suggest that neither osteoporosis nor osteoporotic fractures were frequent among prehistoric and historic populations.

References

AHLSTRÖM, C. G., HAKANSSON, S. and DALIN, T. (1978): The mummy at the Museum Stobaeanum in Lund. - Sydsvenska medicinhistoriska sallkapets arsskrift *15*, 17-42.

ALDRED, C. and SANDISON, A. T. (1962): The pharaoh Akhenatos, a problem in Egyptian pathology. - Bull. Med. Hist. *34*, 293-316.

APPELBOOM, T. and BODY, J. J. (1993): The antiquity of osteoporosis. More questions than answers. - Calcif. Tissue Int. *53*, 567-569.

BELL, K. L., LOVERIDGE, N., KNEISSEL, M. et al. (1996): Circumferential distribution of bone within the femoral neck cortex in an archeological and present-day population (Abstr.). - Bone *18*, Suppl. 196.

BENNIKE, P. (1985): Paleopathology of Danish skeletons. - Munksgaard, Copenhagen.

BERG, E. (1972): Paleopathology: Bone lesions in ancient peoples. - Clin. Orthop. Rel. Res. *82*, 263-267.

BOURKE, J. B. (1971): The paleopathology of the vertebral column in ancient Egypt and Nubia. - Med. Hist. *5*, 363-380.

BRAUNSTEIN, E. M., WHITE, S. J., RUSSEL, W. et al. (1988): Paleoradiologic evaluation of the Egyptian royal mummies. - Skelet. Radiol. *17*, 348-352.

BROTHWELL, D. and SANDISON, AT., (1967): Diseases in antiquity. - Thomas, Springfield.

BROTHWELL, D., SANDISON, A. T. and GRAY, P. H. K. (1969): Human biological observations on a Gauchan mummy with anthracosis. - Am. J. Phys. Anthropol. *30*, 338-347.

BURR, D. B., RUFF, C. B. and THOMPSON, D. D. (1990): Patterns of skeletal histologic change through time: Comparison of an archaic native American population with modern populations. - Anat. Rec. *226*, 307-310.

CAMPILLO, D. and VIVES, E. (1985-86): Exposición du nuestra experiencie paleopatológica de época mediéval. - Dynamis *5*, 31-58.

COCKBURN, A., BARRACO, R. A., REYMAN, T. A. et al. (1975): Autopsy of an Egyptian mummy. - Science *187*, 1155-1160.

DÓCZI, J., PAP, I. and JÓZSA L. (in preparation): Bone mineral density of radius in Medieval skeletons.

EKENMAN, I., ERIKSSON, S. A. V. and LINDGREN, J. H. (1995): Bone density in Medieval skeletons. - Calcif. Tissue Int. *56*, 355-358.

ELLIOT-SMITH, G. and DAWSON, W. R. (1924): Egyptian mummies. - Dial Press, New York.

EL-NAJJAR, M. Y., BENITES, J., FRY, G., et al. (1980): Autopsies on two native American mummies. - Am. J. Phys. Anthropol. *53*, 197-202.

ENDES, J. and VARGHA, Gy. (1988): Egyiptomi múmiák röntgenvizsgálata. - M. Radiológia *62*, 27-38.

ERICKSEN, M. F. (1976): Cortical bone loss with age in three native American populations. - Am. J. Phys. Anthropol. *45*, 443-452.

FARKAS, GY., MARCSIK, A. and OLÁH, S. (1993): A történeti idők embere Szegváron. - Anthrop. Közl. *35*, 7-37.

FRIGO, P. and LANG, E. (1995): Osteoporosis in a woman of the early Bronze Age. - N. Engl. J. Med. *333*, 1468.

FRIGO, P., LANG, E., LAUERMANN, E. et al. (1996): Age and sex-dependent differences in bone density in 4000-year-old individuals from an excavation in Unterhautzenthal, Lower Austria. (Abstr.) - Bone *18*, Suppl. 117.

GRAY, P. H. K. (1967): The radiography of ancient Egyptian mummies. - Med. Radiogr. Photogr. *43*, 34-44.

GRAY, P. H. K. (1973): The radiography of mummies of ancient Egypt. - J. Hum. Evol. *2*, 51-60.

GUNNES-HEY, M. (1980): Eskimo presacral vertebral column: variations, anomalies, pathologies. - Ossa *7*, 99-118.

GUNNES-HEY, M. (1985): Age-related bone loss in prehistoric Koniag Eskimo population. - Ossa *12*, 41-47.

HAHN, K. and CZARNETZKI A., (1980): Premature senescence of the skeleton of a young woman from the Merovingian burial field of Weresheim. - Anthropol. Contemp. *3*, 137-144.

HAMADA, G. and RIDA, A. (1972): Orthopedics and orthopedic diseases in ancient and modern Egypt. - Clin. Orthop. Rel. Res. *89*, 253-268.

HARRIS, J. E. and WENTE, E. F. (1980): An X-ray atlas of royal mummies. - Univ. Press, Chicago.

HENN, R. (1993): Der Mann in Eis. Vol. I. - Univ. Press, Innsbruck.

HODLER, J., ULRICH, S. and RÜTTIMANN, B. (1990): Computertomographie in der Paleopathologie. - Z. Orthop. *124*, 319-321.

HUSSEIN, M. K. (1949-50): Quelques specimens de pathologie osseuse chez les ancient egyptiens. - Bull. Inst. Egypte (Cairo) *32*, 11-70.

HÜBENER, K. H. and PAHL, W. M. (1981): Computertomographische Untersuchungen an agyptischen Mumien. - Fortschr. Röntgenstr. *135*, 213-219.

JÓZSA, L. (1996): A honfoglaló és Árpád-kori magyarság egészsége és betegségei. - Gondolat, Budapest.

JÓZSA, L. and Pap, I. (1996): Az osteoporosis előfordulása a X-XII századi magyarság körében. - Osteológiai Közl. *4*, 126-129.

JÓZSA, L., DÓCZI, J. and PAP, I. (1996): Az osteoporosisra jellemző combnyaktáji és radiustörések a történeti korokban. - M. Traumatológia (accepted for publication).

KNEISSEL, M., BOYDE, A., HAHN, M., et al. (1994): Age and sex-dependent cancellous bone changes in a 4000 y BP population. - Bone *15*, 539-545

KRAMAR, C., LAGIER, R. and BAUD, C. A. (1990): Rheumatic diseases in Neolithic and Medieval populations of Western Switzerland. - Z. Rheumatol. *49*, 338-345.

KUO-LIANG, Y., BING, B. Q., YUE, Z. et al. (1982): Skin changes of a 2100-year-old Changsha female corpse. - Chin. Med. J. *93*, 765-770.

LAGIER, R., BAUD, C. A., ARNAUD, G. et al. (1982): Lesions characteristic of infection or malignant tumor in Paleo-Eskimos. - Virchow Arch. Path. Anat. A. *395*, 237-243.

LEAKEY, M. G., FEIBEL, C. S., MCDOUGALL, I. et al. (1995): New four-million-year-old hominid species from Kanopi and Allia Bay, Kenya. - Nature *376*, 565-571.

LEES, B., MOLLESON, T., ARNETT, T. R. et al. (1993): Differences in proximal femur bone density over two centuries. - Lancet *341*, 673-675.

LEES, B., MOLLESON, T., ARNETT, T. R. et al. (1995): Gender differences in bone loss over two centuries. (Abstr.) - Bone *117*, 326.

LESTER, C. W. and SHAPIRO, H. L. (1968): Vertebral arch defects in the lumbar vertebrae of pre-historic American Eskimos. - Am. J. Phys. Anthropol. *28*, 43-48.

LEWIN, P. K. (1978): Whole body scan of an Egyptian mummy using X-ray computed tomography. - Paleopath. Newsletter *22*, 17-18.

LEWIN, P. K., TROGADIS, J. F. and STEVENS, J. K. (1990): Three-dimensional reconstruction from serial X-ray tomography of an Egyptian mummified head. - Clin. Anat. *3*, 215-218.

LEWIN, P. K. (1991): Technological innovation in the investigation of ancient preserved man. In: ORTNER, D. J. and AUFDERHEIDE, A. C. (eds): Human paleopathology. - Smithsonian Inst. Press, Washington, 90-91 pp.

LUZSA, GY., GÁSPÁRDY, G., NEMESKÉRI, J. et. al. (1988): Paleoradiológiai tanulmány a székesfehérvári bazilika 15 csontmaradványáról. - M. Radiológia *62*, 39-50.

MARX, M. and D'AURIA, S. H. (1988): Three-dimensional CT reconstruction of an ancient Egyptian mummy. - Am. J. Radiol. *150*, 147-149.

MOLNÁR, E., MARCSIK, A., FARKAS, L. GY., DUTOUR, O., PANUEL, M. and PÁLFI, Gy. (1996): Szatymaz-Vasútállomás X-XII századi embertani széria paleopathológiai feldolgozása. In: PÁLFI, GY., FARKAS, L. Gy. and MOLNÁR, E. (eds): Honfoglaló magyarság - Árpád-kori magyarság. - JATE Embertani tanszék, Szeged, 235-250 pp.

MOODIE, R. L. (1931): Roentgenologic studies of Egyptian and Peruvian mummies. - Field Museum, Chicago.

PALES, L. (1930): Paleopathologie et pathologie comparative. - Masson et Cie, Paris.

PAP, I. and Susa É. (1986): Complex anthropological analysis of cemetery of the comitat center Visegrád. - Anthrop. Hung. *19*, 51-91.
PERZIGIAN, A. J. (1973): Osteoporotic bone loss in two prehistoric Indian populations. - Am. J. Phys. Anthropol. *39*, 87-96.
PFEIFFER, S. and KING, P. (1983): Cortical bone formation and diet among prehistoric Iroquoians. - Am. J. Phys. Anthropol. *60*, 23-28.
PIEPERBRINK, H., FRAHM, J., HAASE, A. et al. (1986): Nuclear magnetic resonance imaging of mummified corpses. - Am. J. Phys. Anthropol. *70*, 27-35.
REIMERS, E. G., DE LA ROSA, M. A., MARTIN, L. G. et al. (1988): Bone histology of the prehispanic inhabitants of Grand Canaria. - J. Paleopath. *2*, 47-59.
RUFFER, M. A. (1921): Studies on paleopathology of Egypt. - Univ. Press, Chicago.
SHAW, A. F. B. (1938): Histological study of the mummy Haar-Mose, singer of the eighteenth dynasty (circa 1940 BC). - J. Path. Bacteriol. *47*, 115-123.
SIMPER, L. B. (1986): Spondylolysis in Eskimo skeletons. - Acta Orthop. Scand. *57*, 78-80.
SMITH, E. G. (1908): The unwrapping of a pharaoh. - Brit. Med. J. *1*. 732-734.
SUSMAN, R. L. (1994): Fossil evidence for early hominid tool use. - Science *265*, 1370-1373.
THOULD, A. K. and THOULD B. T. (1983): Arthritis in Roman Britain. - Brit. Med. J. *287*, 1909-1911.
TRINKAUS, E. and HOWELLS, W. W. (1979): The Neanderthals. - Sci. Am. *241*, 118-133.
TRINKAUS, E. and ZIMMERMAN, M. R. (1982): Trauma among the Shanidar Neanderthals. - Am. J. Phys. Anthropol. *57*, 61-76,
TRINKAUS, E. (1983): Functional aspects of Neanderthal pedal remains. - Foot and Ankle *3*, 377-390.
VAN GREEVEN D. P., ARMELAGOS, G. J. and BARTLEY, M. M. (1969): Roentgenographic and direct measurements of cortical involution in prehistoric Mississipian population. - Am. J. Phys. Anthropol. *31*, 23-28.
WALDRON, T. (1990): Note on a mummy from Theban tombs. - J. Paleopath. *3*, 89-94.
WEI, O. (1973): Internal organs of a 2100-year-old female corpse. - Lancet I. 1198-1199.
WELLS, C. (1962): Joint pathology in ancient Anglo-Saxons. - J. Bone Joint Surg. (Brit.) *44*, 948-949.
WELLS, C. (1963): Hip disease in ancient man. - J. Bone Joint Surg. (Brit.) *45*, 790-791.
WELLS, C. (1964): Bones, bodies and diseases. - Thames and Hudson, London.
WILLIAMS, H. U. (1927): Gross and microscopic anatomy of two Peruvian mummies. - Arch. Path. *4*, 26-33.
WOOD, B. (1992): Origin and evolution of the genus Homo. - Nature *355*, 783-790.
WOOD-JONES, P. (1908): The examination of the bodies of 100 men executed in Nubia in Roman times. - Brit. Med. J. *1*, 736-740.
WU, Z. B. (1981): Electron microscopic study of a well-preserved 2142-year-old ancient corpse. - Acta Med. Acad. Wuhan *1*, 7-16.
ZIMMERMAN, M. R. (1977): Autopsy of an Egyptian mummy (Nakht Rom I.). - Canad. Med. Ass. J. *117*, 461-476.
ZIMMERMAN, M. R. (1980): Aleutian and Alaskan mummies. In: COCKBURN, A. (ed.): Mummies, diseases and ancient cultures. - Cambridge Univ. Press, London.
ZIMMERMAN, M. R., TRINKAUS, E., LE MAY, M. et al. (1981): The paleopathology of an Aleutian mummy. - Arch. Pathol. Lab. Med. *105*, 638-641.

ACTA BIOL. SZEGED. 42, pp. 81-88 (1997)

PHENOGRAMS DUE TO DIFFERENT SET OF NON-METRIC TRAITS

ZS. JUST[1] and M. FINNEGAN[2]

[1]*Department of Anthropology, József Attila University, H-6701 Szeged, Hungary*
[2]*Department of Sociology, Anthropology and Social Work, Kansas State University, Manhattan, 66503 Kansas, USA*

(Received: Januar 20, 1997)

Abstract

904 crania representing 11 Arpadian-age populations were subjected to non-metric trait analysis in order to highghlight the biological affinities among them.

A phenogram generated from the frequencies of the parent set of variables, consisting of 41 non-metric traits, differs from those phenograms which were built up on the basis of reduced and specialized subsets of non-metric traits. One generated subset of variables involves sutural variations, the other is limited to foramen variations.

Key words: affiliated or subset of non-metric traits, biological distance or mean measure of divergence (MMD), Arpadian-age

Introduction

A study of 11 Arpadian-age populations concerning the occurrence of 41 non-metric cranial traits and a generated biological distance analysis (JUST, 1996) provides the opportunity for further investigations on the features of non-metric traits.

Two reduced and specialized subsets of non-metric traits were selected from the above 41 non-metric traits: a set of foramen variables (Table 2) and a set of sutural variables (Table 2).

This paper examines whether the phenograms derived from these subsidiary non-metric data sets differ from each other and from the phenogram generated from the frequencies of the original non-metric traits. In other words this research compares the mean measure of divergence (MMD) or biological distance produced by different sets of non-metric traits using the same sample.

Materials and method

A sample of 904 crania representing 11 Arpadian-age (11th-14th A.D. century) populations was scored for 41 non-metric cranial traits in a previous study (JUST, 1996). Sample names, abbreviations, sample size and the date of the sample are presented in Table 1.

From the above 41 non-metric variables two subsets of variables were separated: a subset of the 11 sutural variables includes sutural ossicles and persisting sutures and a foramen subset consisting of 12 traits, including accessory foramen and foramen with multiple alternative expression.

The frequency data of these subsets were separately subjected to the GREWAL-SMITH statistics (GREWAL, 1962; FINNEGAN and COOPRIDER, 1978; FINNEGAN et al., 1993) which transforms the basic trait frequencies into a mean measure of divergence (MMD) or biological distance among all population pairs.

Each matrix was moved to a statistical package (ROLF et al., 1974) which generated a phenogram. Each matrix was subjected to a TAXON analysis which provided a sequential agglomerative, hierarchical cluster analysis in which we employed the unweighted pair-group method using arithmetic averages and dictated that the lowest values were considered for similarity. The routine MXCOMP, which computes the cophenetic values for each matrix position, was employed and the resultant cophenetic value matrix was compared to the original matrix for congruence. (SOKAL and SNEATH, 1963).

Table 1. Sample names, date of samples by centurties, abbreviations of sample names, sample sizes by the number of studied crania.

site	century	abbrev.	size
Békés-Povádzug	10-12.sz.	bep	58
Cegléd-Borzahegy *	11-13.sz.	ceb	37
Cegléd-Madarászhalom *	11-13.sz.	cem	94
Csátalja-Vágotthegy	11-13.sz.	csát	43
Csongrád-Felgyő	10-11.sz.	csof	29
Hódmezővásárhely-Kardoskút	11-12.sz.	hvk	123
Jászdózsa-Kápolnahalom *	11-14.sz.	ják	41
Kiszombor B	10-12.sz.	kisz	80
Orosháza-Rákóczitelep	10-12.sz.	ort	157
Szatymaz-Vasútállomás	10-12.sz.	szva	70
Szegvár-Oromdűlő	10-12.sz.	szeg	172
total			904

Results and discussion

A list of the chosen variables and their frequencies for each population sample is presented in Table 2. Frequencies presented in this table served as basic data for the GREWAL-SMITH distance statistic. MMDs (biological distances) among all population pairs generated from the frequencies of sutural variables are given in Table 3; the same for foramen variables are presented in Table 4. Underwritten figures are estimates of the variance. Significant differences between pairs at the level of $p < 0.05$ are indicated with a + while an * indicates significant differences at the level of $p < 0.01$. Most of the biological distances calculated from sutural trait frequencies are not significant, while most of the biological distances based on foramen variables are significant ($p < 0.05$) or very significant ($p < 0.01$). Some population sample pairings produced negativ biological distance values. This is an artifact of the GREWAL-SMITH statistic, produced when frequency differences between population pairs are very small. In order to avoid

Table 2. Proportion and frequencies of each traits in each population samples. Frequencies presented in this table served as basic data for the GREWAL-SMITH distance statistics. n = number of positiv observations, N = actual sample size for the given trait, p = frequency.

Non-metric variations	bep		ceb		cem		csát		csof		hvk	
	n/N	P	n/N	P	n/N	P	n/N	P	n/N	P	n/N	P
Sutural variations												
1.Sutura metopica	5/ 57	0.088	1/36	0.028	6/92	0.065	3/36	0,083	0/27	0.000	5/121	0.041
2.Os bregmaticum	0/ 55	0.000	0/36	0.000	1/90	0.011	0/35	0.000	0/27	0.000	0/118	0.000
3.Os incae	0/ 54	0.000	1/36	0.028	4/87	0.046	0/30	0.000	0/24	0.000	0/112	0.000
4.Os lambdae (apicis)	9/ 49	0.184	2/32	0.063	13/89	0.146	3/30	0.100	2/24	0.083	21/113	0.186
5.Ossa suturae sagittalis	8/ 49	0.163	2/27	0.074	7/86	0.081	1/31	0.032	0/26	0.000	10/110	0.091
6.Os epiptericum	5/ 66	0.076	5/58	0.086	28/120	0.233	10/37	0.270	7/34	0.206	27/147	0.184
7.Os astericum	4/ 98	0.041	2/66	0.030	15/157	0.096	0/51	0.000	0/41	0.000	17/170	0.100
8.Ossiculum incisurae parietalis	11/103	0.107	3/66	0.045	22/161	0.137	6/51	0.118	2/46	0.043	18/170	0.106
9.Ossa Wormiana	38/ 96	0.396	18/62	0.290	99/169	0.586	17/61	0.279	27/47	0.574	102/218	0.468
10.Ossa suturae coronalis	2/ 88	0.023	1/70	0.014	9/164	0.055	0/59	0.000	2/54	0.037	6/219	0.027
11.Os japonicum	0/ 82	0.000	0/63	0.000	0/159	0.000	0/47	0.000	0/46	0.000	0/143	0.000
Foramen variations												
12.Foramen parietale	29/112	0.259	15/70	0.214	68/171	0.398	10/55	0/182	7/54	0.130	91/233	0.391
13.Foramen frontale	28/107	0.262	17/70	0.243	11/175	0.063	9/66	0.136	13/53	0.245	28/233	0.120
14.Foramen supraorbitale	28/107	0.262	6/70	0.086	64/175	0.366	12/70	0.171	9/53	0.170	48/233	0.206
15.Foramen infraorbitale accessorius	11/ 75	0.147	5/56	0.089	33/144	0.229	4/38	0.105	6/41	0.146	18/142	0.127
16.Foramen zygomatico-faciale access.	27/ 81	0.333	16/63	0.254	54/160	0.338	17/49	0.347	12/46	0.261	50/145	0.345
17.Foramen mastoideum exsuturális	30/102	0.294	15/68	0.221	66/180	0.367	9/63	0.143	13/48	0.271	61/188	0.324
18.Foramina palatinum minus access.	31/ 73	0.425	15/53	0.283	58/134	0.433	11/34	0.324	10/29	0.345	62/134	0.453
19.Canalis condylaris apertus	26/61	0.426	16/53	0.302	80/152	0.526	17/49	0.347	15/42	0.357	64/137	0.467
20.Foramen mentale accessorium	2/101	0.020	0/50	0.000	6/151	0.040	0/66	0.000	0/51	0.000	4/165	0.024
21.Foramen palatinus	3/ 79	0.038	0/64	0.000	6/164	0.037	1/48	0.021	2/45	0.044	2/153	0.013
22.Foramen zygomatico-faciale absens	19/ 80	0.238	15/62	0.242	28/161	0.174	10/47	0.213	11/46	0.239	34/145	0.234
23.Foramen mastoideum absens	42/ 91	0.462	38/66	0.576	72/178	0.404	29/44	0.659	29/34	0.615	41/178	0.230

Table 2. (continued).

Non-metric variations	ják		kisz		ort		szva		szeg	
	n/N	P	n/N	P	n/N	P	n/N	P	n/N	P
Sutural variations										
1.Sutura metopica	12/155	0.077	4/ 70	0.057	9/142	0.063	2/39	0.051	8/ 80	0.100
2.Os bregmaticum	0/145	0.000	1/ 67	0.015	2/139	0.014	2/40	0.050	3/ 80	0.038
3.Os incae	1/147	0.007	2/ 65	0.031	2/135	0.015	1/38	0.026	2/ 80	0.025
4.Os lambdae (apicis)	19/144	0.132	8/ 64	0.125	29/135	0.215	7/37	0.189	12/ 78	0.154
5.Ossa suturae sagittalis	9/138	0.065	4/ 63	0.063	19/122	0.864	3/35	0.086	3/ 76	0.039
6.Os epiptericum	35/188	0.186	15/110	0.136	36/162	0.222	20/70	0.286	24/151	0.159
7.Os astericum	18/230	0.078	12/126	0.095	19/244	0.078	7/74	0.095	13/157	0.083
8.Ossiculum incisurae parietalis	29/239	0.121	12/127	0.094	44/154	0.286	13/75	0.173	21/155	0.135
9.Ossa Wormiana	120/288	0.417	50/126	0.397	160/266	0.602	41/70	0.586	68/151	0.450
10.Ossa suturae coronalis	7/279	0.025	2/127	0.016	10/232	0.043	11/74	0.149	8/158	0.051
11.Os japonicum	1/228	0.004	0/104	0.000	2/243	0.008	1/69	0.014	0/156	0.000
Foramen variations										
12.Foramen parietale	119/294	0.405	47/135	0.348	102/271	0.376	37/78	0.474	56/157	0.357
13.Foramen frontale	43/303	0.142	17/132	0.129	22/263	0.084	1/76	0.013	5/157	0.032
14.Foramen supraorbitale	77/300	0.257	35/131	0.267	81/266	0.305	31/77	0.403	41/158	0.259
15.Foramen infraorbitale accessorius	34/208	0.163	25/107	0.234	38/183	0.208	26/71	0.366	23/153	0.150
16.Foramen zygomatico-faciale access.	85/232	0.366	31/108	0.287	97/249	0.390	20/71	0.282	56/156	0.359
17.Foramen mastoideum exsuturális	105/274	0.383	50/128	0.391	85/269	0.316	40/76	0.526	75/155	0.484
18.Foramina palatinum minus access.	71/183	0.388	26/102	0.255	50/141	0.355	35/59	0.507	54/139	0.388
19.Canalis condylaris apertus	64/176	0.364	33/123	0.268	85/172	0.494	35/63	0.556	70/148	0.473
20.Foramen mentale accessorium	9/220	0.041	3/ 82	0.037	8/299	0.027	4/54	0.074	6/152	0.039
21.Foramen palatinus	0/232	0.000	0/110	0.000	2/231	0.009	1/64	0.016	5/155	0.032
22.Foramen zygomatico-faciale absens	30/195	0.154	8/ 78	0.103	42/254	0.165	11/71	0.155	38/156	0.244
23.Foramen mastoideum absens	28/202	0.139	8/ 60	0.133	125/251	0.498	17/74	0.230	58/155	0.374

negativ distance values during the cluster analysis, all MMD distance measures were increased by 0.010 before the matrix was submitted to the cluster programs.

The phenogram in Fig. 1 presents population clusters based on the distance matrix of sutural variables. The phenogram in Fig. 2 shows clustering of the population samples using the foramen distance matrix. In comparing phenograms from the sutural matrix to the phenogram from the sutural cophenetic matrix, a correlation of 0.739 was achieved while the foramen variables generated a correlation of 0.625. For the limits of this study, these internal correlations may be considered significant.

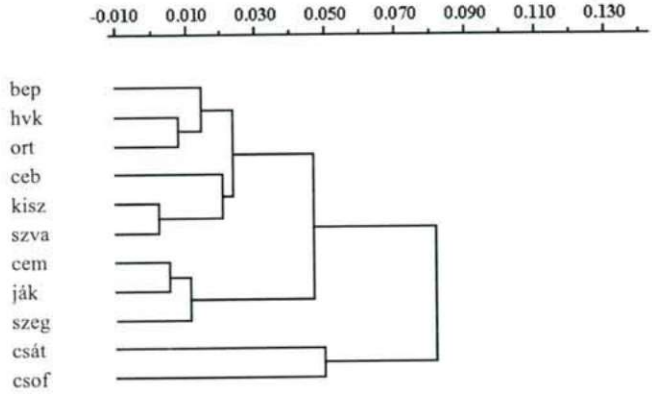

Fig. 1. Phenogram based on the clustered distance matrix of sutural variables. Abscissa is scaled in relative population distances.

In analysing specific diffrences between the sutural and foramen generated phenograms, we find that four major clusters develop on the sutural phenogram: union of BEP, HVK and ORT compose the first cluster, CEB, KISZ and SZVA form the next, while the third cluster includes the samples of CEM, JÁK and SZEG. If 0.040 (an arbitrary, but logical value based on the original distance matrix) is considered to be a cluster identity level, CSÁT and CSOF come together above this level.

The phenogram drawn from the foramen distance matrix divides into three major clusters: BEP, CEB, CSÁT and CSOF form the first unit, CEM, SZEG, KISZ and JÁK compose the next cluster and than the triad of HVK, ORT and SZVA joins as the third cluster. JÁK meet the second cluster at a higher level, somewhat above the 0.040 identity level.

In comparing sutural, foramen and parent phenograms (Fig. 3) only two pairs of samples consistently cluster together: HVK with ORT and CSOF with CSÁT seem to be inseparable. The close relation between HVK and ORT can be supported by their geographical proximity, however the same situation does not hold true for CSÁT and CSOF.

Table 3. Measures of divergence (biological distance) based on sutural variables between population samples used in this study. Underwritten figures in italics are estimates of the variance. Levels of significance: + (p<.05); * (p<.01)

	BEP	CEB	CEM	CSAT	CSOF	HVK	JAK	KISZ	ORT	SZEG
CEB	0.010									
	0.016									
CEM	0.045+	0.055+								
	0.010	*0.014*								
CSAT	0.041	0.019	0.088							
	0.017	*0.021*	*0.015*							
CSOF	0.102+	0.052	0.083+	0.040						
	0.020	*0.023*	*0.017*	*0.024*						
HVK	0.003	0.029	0.017	0.048	0.065					
	0.010	*0.013*	*0.007*	*0.014*	*0.016*					
JAK	0.078+	0.108+	-0.005	0.132*	0.108+	0.040+				
	0.015	*0.019*	*0.013*	*0.020*	*0.022*	*0.012*				
KISZ	0.030	0.035	0.001	0.060+	0.084+	0.020	0.011			
	0.011	*0.014*	*0.008*	*0.015*	*0.017*	*0.007*	*0.013*			
ORT	0.007	0.013	0.013	0.026	0.066+	-0.002	0.039+	0.008		
	0.009	*0.012*	*0.006*	*0.013*	*0.016*	*0.005*	*0.011*	*0.007*		
SZEG	0.033+	0.083*	0.001	0.099*	0.114*	0.018+	0.000	0.022+	0.024+	
	0.009	*0.012*	*0.006*	*0.013*	*0.016*	*0.006*	*0.011*	*0.007*	*0.005*	
SZVA	0.012	-0.004	0.007	0.042	0.074+	0.007	0.039	-0.008	-0.003	0.028+
	0.012	*0.015*	*0.009*	*0.016*	*0.018*	*0.008*	*0.014*	*0.009*	*0.007*	*0.008*

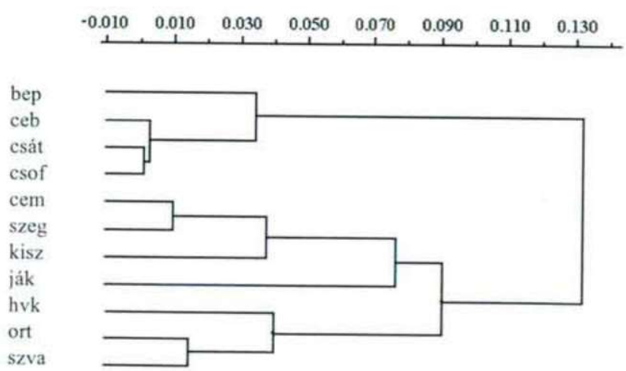

Fig. 2. Phenogram based on the clustered distance matrix of foramen variables. Abscissa is scaled in relative population distances.

On the sutural phenogram HVK and ORT join to BEP; on the phenogram based on the clustered distance matrix of foramen variables they meet SZVA. Comparing these subset phenograms to the original, parent phenogram based on the 41 non-metric trait set, BEP, HVK, ORT and SZVA are all found in the same cluster. Similarly, CEM and JÁK cluster in the sutural phenogram while in the foramen phenogram CEM and KISZ meet below the 0.040 identity level and JÁK joins this group above this identity level. In the parent phenogram these three population samples belong to the same cluster.

Table 4. Measures of divergence (biological distance) based on foramen variables between population samples used in this study. Underwritten figures in italics are estimates of the variance. Levels of significance: + (p<.05); * (p<.01)

	BEP	CEB	CEM	CSAT	CSOF	HVK	JAK	KISZ	ORT	SZEG
CEB	0.037+									
	0.011									
CEM	0.036+	0.149*								
	0.007	*0.009*								
CSAT	0.039+	-0.006	0.123*							
	0.013	*0.015*	*0.011*							
CSOF	0.000	-0.008	0.102*	-0.009						
	0.014	*0.016*	*0.012*	*0.018*						
HVK	0.026+	0.094*	0.027+	0.104*	0.089*					
	0.007	*0.009*	*0.005*	*0.011*	*0.012*					
JAK	0.140*	0.295*	0.027+	0.294*	0.245*	0.071*				
	0.011	*0.013*	*0.008*	*0.014*	*0.015*	*0.008*				
KISZ	0.059*	0.117*	0.032*	0.085*	0.077*	0.084*	0.103*			
	0.007	*0.009*	*0.005*	*0.011*	*0.012*	*0.005*	*0.009*			
ORT	0.068*	0.143*	0.054*	0.178*	0.152*	0.014+	0.071*	0.140*		
	0.007	*0.008*	*0.004*	*0.010*	*0.011*	*0.004*	*0.008*	*0.004*		
SZEG	0.023+	0.086*	0.002	0.070*	0.063+	0.033*	0.071*	0.024+	0.061*	
	0.006	*0.008*	*0.004*	*0.010*	*0.011*	*0.004*	*0.008*	*0.004*	*0.004*	
SZVA	0.092*	0.140*	0.084*	0.188*	0.151*	0.047*	0.094*	0.166*	0.005	0.081*
	0.008	*0.010*	*0.006*	*0.012*	*0.013*	*0.006*	*0.010*	*0.006*	*0.006*	*0.005*

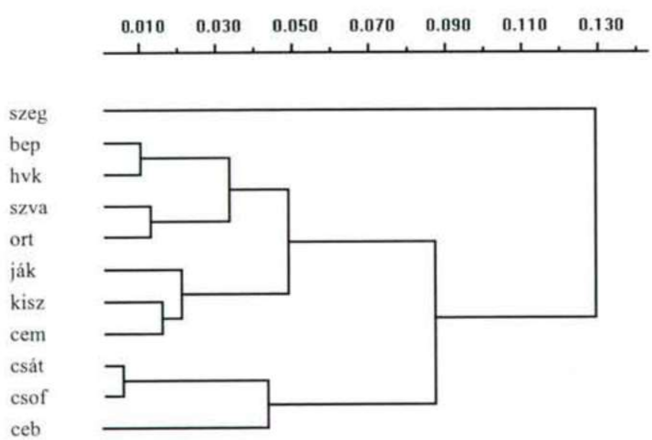

Fig. 3. Phenogram based on the clustered distance matrix of the original 41 non-metric traits. Abscissa is scaled in relative population distances.

Although, these parallels can be discovered among the phenograms, inconsistency exists as far as biological distances are concerned. For example, HVK and ORT meets at a higher level on the foramen phenogram than on the sutural phenogram and the relative MMD between CSÁT and CSOF is higher on the sutural phenogram than on the foramen phenogram.

Because of the inconsistencies seen in the sutural, foramen and parental phenograms, it is currently not possible to ascertain the precise contribution either the sutural or foramen subset of variables provides to the separation of clusters seen in these phenograms.

Acknowledgments

The authors are indebted to a number of colleagues who assisted in various phases of this research. Particularly, Dr. KINGA ÉRY was instrumental in codifying our thoughts about comparing subset data within this list of popular non-metric traits.

References

FINNEGAN, M. and COOPRIDER, K. (1978): Empirical comparison of distance equations using discrete traits. - Am. J. Phys. Anthrop. *49*, 39-46.

FINNEGAN, M., TÓTH, T., FERENCZ, M., FÓTHI, E. and PAP, I. (1993): Biological distance during the Avar period based on non-metric cranial data. - Ann. Hist.-Nat. Mus. Nat. Hung. *85*, 181-202.

GREWAL, M. S. (1962): The rate of genetic divergence of sublines in the C57BL strain of mice. - Genet. Res. *3*, 226-237.

JUST, Zs. (1996): Alföldi Árpád-kori népességek biológiai kapcsolatainak rekonstrukciója a koponya non-metrikus jellegeinek alapján. (Biological relationships between Arpadian-age population samples from the Great Hungarian Plain using non-metric cranial traits.) - Dr. Univ. Thesis, József Attila University, Szeged.

ROLF, F. J., KISPAUGH, J. and KIRK, D. (1974): Numerical taxonomy system of multivariate statistical programs. - Department of Ecology and Evolution, The State University of New York at Stony Brook, Stony Brook, New York 11790.

SOKAL, R. R. and SNEATH, P. H. A (1963): Principles of numerical taxonomy. - W. H. Freeman and Company, San Francisco.

ACTA BIOL. SZEGED. 42, pp. 89-93 (1997)

THE RELATIONSHIP OF CORRECT OCCLUSION AND ATTRITION IN PREHISTORIC AND CIVILIZED MAN, ON THE BASIS OF BEGG'S OCCLUSAL THEORY

A. KOCSIS and G. KOCSIS S.

Clinic of Dentistry and Oral Surgery, Albert Szent-Györgyi Medical University
H-6720 Szeged, Tisza Lajos krt. 64., Hungary

(Received: December 10, 1996)

Abstract

Occlusal and approximal attrition is correlated to the mesial and vertical migration of the teeth. Mandibular growth is also a very important factor in the development of dental arches. The purpose of this article is to examine the difference between the dentition of civilized and prehistoric man and to establish whether mandibular reduction can cause occlusal dysharmony in the evolutionary process. The research was based on BEGG's theory.

Key words: attrition, migration, dental arch reduction, mandibular reduction.

Introduction

It has been observed by anthropologists and orthodontists that the occurrence of crowded teeth is less frequent in primitive human groups than in civilized population. In the latter case, malocclusion is quite recurrent. It has also been stated that the evolutionary reduction of jaw size is greater than the reduction of teeth size. The Australian BEGG, one of the disciples of ANGLE, dealt with the theory of occlusion.

In BEGG's occlusal theory, the phylogenetic development of the dentition and jaw bones was taken into consideration. Correct occlusion is not a static condition and a fixed anatomic state, but a changing functional process undergoing continual modification and adjustment during the whole life of both deciduous and permanent dentitions.

The relationship of the individual teeth in the same arch, the relationship of the teeth of one arch to those of the opposite arch, and the positional relationships of the teeth to the jaw bones change continually throughout life. Two important factors in correct occlusion are the positions of the teeth in the jaw bones and the anatomy of the individual teeth. These factors contribute to the reduction of the alveolar process and the development of adequate dental arch length.

Discussion

The migration of teeth is a basic physiological factor. It determines the positions of the teeth in the jaw bones. Throughout life, the teeth continually migrate in two directions (GOTTLIEB, 1927): horizontally (mesial migration) and vertically (continual eruption). Continual mesial migration and continual vertical eruption compensate for tooth attrition (MURPHY, 1959a).

Many writers (STRANG, 1943; HUCKABA, 1952) refer to the forward migration of the teeth as if it were an abnormal and undesirable phenomenon that causes the teeth to move bodily forward and to tip or lean obliquely forward, thus producing malocclusion such as crowding of the teeth, especially the anterior teeth, and also the condition known as bimaxillary protrusion. These writers consider that this forward migration of the teeth is due to abnormal and perverted muscular forces from the lips, cheeks, tongue and throat, and also to perversion of the axial stress of the teeth during mastication. "Anterior component of forces" is the name used in the orthodontic literature to designate the force, from whatever source it is considered to emanate, that causes this undesirable mesial migration of the teeth. Although mesial tooth migration does produce malocclusions, it is a normal physiologic phenomenon.

Another important factor in the development and maintenance of correct occlusal relationships is the changing anatomy of the teeth. The anatomic forms of the teeth begin to change soon after eruption. This change is due to tooth wear, which takes place both occlusally and interproximally. According to BROCA's (1879) research, continual loss of tooth substance by attrition is a normal functional process and absence of this loss produces abnormalities. Thus, it can be stated that physiological mesial and vertical migration compensate for the physiological approximal and occlusal attrition. The reduction of the dental arches is not sufficient to fit into the evolutionarily reduced jaw bones. The evolutionary reduction of jaw size may be sufficient to account for many of the grosser conditions of malocclusion and dentofacial anomalies.

The accepted normal textbook occlusion of civilized man is phylogenetically incorrect because his food is too soft and concentrated to cause tooth attrition. The incisal, occlusal, interproximal and axial relations of his teeth remain almost static throughout life because of the firm locking of the unworn cusps. Anatomically correct occlusion can develop only when there is sufficient attrition of the teeth for them to assume correct occlusal relationships (BEGG, 1954).

It may be said that phylogenetic mandibular reduction is compensated by attrition, reducing the size of the dental arch to the size of the jaw bone. This condition is found in Stone Age man. Stone Age man's teeth display occlusal and interproximal attrition, often so marked that the dentine is exposed and much worn occlusally, incisally and interproximally.

Occlusal attrition was arranged into four groups by BROCA (1879). Nine states were recognized by MURPHY (1959b) on the bases of the amount of dentine exposed on the occlusal surface. Approximal attritions were also described and grouped by CAMPBELL (1925), SHAW (1931) and MILES (1962). The existing contact points first become flatter contact surfaces, and during this period the convex aspect of one tooth comes into close contact with the concave aspect of the approximating tooth, and the concave area of the former with the convex area of the latter.

Dental arch reduction was examined in 19 Australian aboriginal skulls by BEGG (1954). He found that before the eruption of the third molar, the reduction was 5.28 mm in one quadrant. His method was as follows. Each tooth was built out or restored to what was judged to be its full original unworn mesiodistal width, and was compared with the size of the discovered abraded teeth. He found that the average reduction in length of the whole dental arch from the distal surface of one seventh molar to the other is 10.56 mm; in addition to the mesial and occlusal abrasion in dental arch reduction, the width of the dental arches (MURPHY, 1964) and the height of the palate (LYSELL, 1958a) were taken into consideration. According to Murphy, the reduction was 3.5 mm, LYSELL (1958b) reported 4.5 mm and GOOSE (1962) found that the reduction was only 3.2 mm. The authors stated that the differences in size of the reduction were due not only to different methods but to diet, hybridization, age and sexual dimorphism. A brief outline of the development of dental arches (deciduous and permanent) in primitive and civilized man follows.

Immediately after eruption of the deciduous incisors, there is an overbite of these teeth. As all the deciduous teeth erupt in Stone Age man, attrition causes a reduction of the size of each tooth occlusally, incisally and interproximally. There is maintenance of occlusal contact. There is also maintenance of interproximal contact because all the teeth move mesially around the curve of the arch and remain in proximal contact. Hence, the occlusal relations of the teeth are such that the distal surface of the lower second deciduous molar is further mesial than the distal surface of the upper second deciduous molar.

Due to extensive interproximal wear and maintenance of the proximal contact of the deciduous teeth, the overall mesiodistal lengths of the upper and lower deciduous dental arches are reduced. Therefore, the first molars erupt into positions further mesially in the jaws than in civilized man. In civilized man, the first molars are never far enough mesially after eruption, nor are they in their anatomically correct positions in the jaws, except perhaps in those rare cases where all the teeth are so relatively small that they remain spaced, and perhaps also in some cases of caries of the deciduous teeth.

When the permanent incisors first erupt, there is an overbite, just as there is throughout life in civilized man. However, mastication of hard, coarse, fibrous, gritty food soon causes Stone Age man's permanent incisors to wear incisally, at first at an oblique angle. The obliquity of the plane of wear of the incisal edges at first points downward and forward; this obliquity is gradually reduced as the lower incisors move labially, relative to the upper incisors.

Ultimately, this plane of wear becomes horizontal and in the same straight line as the flat plane of occlusion of the dentition generally (CAMPBELL, 1925). In civilized man, there is a lack of attrition of the incisors and the overbite becomes permanent.

HUNT (1961) demonstrates that in civilized children, during the second dentition, resorption of the anterior aspect of mandibular ramus takes place and it coincides with the calcification of the crown of the posterior molar teeth. Perhaps this dental stage is traversed in a more mesial position in the primitive mandible and with less resorption.

Accordingly, the primitive mandible at maturity has a border ramus than is seen in most civilized persons. According to BJÖRK (1955), the change in mandibular ramus allows the eruption of the third molars in the narrower, more gracile jaw bones of civilized man, but the eruption is often retarded. Retarded eruption is increased by the lack of vertical and approximal attrition, and the absence of mesial migration and continual eruption in civilized man.

Conclusions

Normal occlusion develops only in those civilized individuals who have too small an amount of tooth substance, if assessed by Stone Age man's requirements, which, after all, are evolutionarily the correct quantitative relationships of tooth to bone. This accounts for there being so relatively few civilized people with the full complement of teeth in normal textbook occlusion.

On the basis of these findings, BEGG's theory can be criticized as follows:

1. A small number of skulls were examined and the results were not interpreted correctly, (MURPHY, 1964), so dental arch reduction was not precisely defined.

2. He did not take into consideration the normal course of the second dentition, e.g. the circumstances of deciduous spacing.

3. He could not have known the accepted theory of mandibular growth, BJÖRK rotation, (BJÖRK and SKIELLER, 1972; 1983), which explains the conditions of the development of the regular and irregular dental arches.

On the other hand, as the dentition of civilized man is rarely abraded, BEGG's suggestion to reduce the length of the dental arch by extraction seems to be acceptable. It can be stated that extraction is the causal therapy of crowding.

References

BEGG, P. R. (1954): Stone Age Man's dentition. - Am. J. Orthod. *40*, 298-312, 373-383, 462-475, 517-531.

BJÖRK, A. (1955): Facial growth in man, studied with the aid of metallic implants. - Acta Odont. Scand. *13*, 9-34.

BJÖRK, A. and SKIELLER, V. (1972): Facial development and tooth eruption. An implant study at the age of puberty. - Am. J. Orthod. *62*, 339-383.

BJÖRK, A. and SKIELLER, V. (1983): Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. - Eur. J. Orthod. *5*, 1-46.

BROCA, P. (1879): Instructions relatives á l'étude anthropologique du systéme dentaire. - Bull Soc. Anthrop. Paris. Sér. *3*, T.2, p.128.

CAMPBELL, T. D. (1925): Dentition and palate of Australian aboriginal. Adelaide.

GOOSE, D. (1962): Reduction of palate size in modern populations. - Arch. Oral Biol. *7*, 343-350.

GOTTLIEB, B. (1927): The Gingival Margin. - Proc. Roy. Soc. Med. Sect. Odont. *20*, 51:54.

HUCKABA, G. W. (1952): The Physiologic basis of relapse. - Am. J. Orthod. *38*, 347.

HUNT, E. (1961): Malocclusion and civilization. - Am. J. Orthod. *47*, 406-422.

LYSELL, L. (1958a): A biometrical study of occlusion and dental arches in a series of medieval skulls from northern Sweden. - Acta Odont. Scand. *16*, 177-203.

LYSELL, L. (1958b): Quantitative and qualitative determiantion of attrition and the ensuing tooth migration. - Acta Odont. Scand. *16*, 267-292.

MILES, A. E. W. (1962): Assessment of the ages of population of Anglo-Saxons from their dentitions. Proc. Roy. Soc. Med. Sect. Odont. *55*, 881.

MURPHY, T. (1959a): Compensatory mechanisms in facial height adjustment to functional tooth attrition. - Australian. Dent. J. *4*, 312-323.

MURPHY, T. (1959b): Gradients of dentine exposure in human molar tooth attrition. - Am. J. Phys. Anthropol. *17*, 179-182.

MURPHY, T. (1964): Reduction of the dental arch by approximal attrition. - British Dent. J. *116*, 483-488.

SHAW, J. C. M. (1931): The teeth, the bony palate and the mandible in Bantu races of South Africa. - London.

STRANG, R. H. W. (1943): Textbook of Orthodontia, ed. 2. Philadelphia, p. 67.

ACTA BIOL. SZEGED. 42, pp. 95-98 (1997)

NEW RECORDS OF HOMINOID RESEARCH AT RUDABÁNYA

L. KORDOS

Geological Institute of Hungary, H-1143 Budapest, Stefánia út 14, Hungary

(Received: December 10, 1996)

Abstract

Rudabánya is a 10 million-year-old Hungarian locality, which has yielded abundant remains of eucatarrhine primates (*Dryopithecus, Anapithecus*), and is rich in plant remains, molluscs and a wide range of vertebrates. The fossiliferous layers were discovered more than 50 years ago, and the first Primates were found in 1967. During the past 5 years, an international multidisciplinary research team has studied different aspects of the site and collected fossils. The short article is a brief summary of the latest results of the team work.

Key words: Primates, Hominoidea, *Dryopithecus, Anapithecus*, Upper Miocene, Hungary, Rudabánya

Primates from Rudabánya

Over a period of 30 years, intermittent collection combined with intensive excavation has led to the recovery of 150 accessioned fossil primate specimens from the late Miocene locality of Rudabánya (Hungary), the vast majority from locality II. This sample, attributed to the great ape *Dryopithecus brancoi* (= *Rudapithecus hungaricus* KRETZOI) and a primitive catarrhine *Anapithecus hernyaki* KRETZOI, includes 3 partial crania, four additional maxilla, six mandibular specimens, 205 isolated or associated loose teeth, and 36 postcranial specimens, representing one of the richest samples of fossil catarrhines in the world (BEGUN and KORDOS, 1996).

As concerns the systematic determination of the Rudabánya primate fossils, of course, several different opinions have been published. In the early 1970s, KRETZOI thought that *Rudapithecus* belongs with *Ramapithecus* described from India, and thus is a direct ancestor of the *Homo* that emerged in Asia (KRETZOI, 1975). Today, most experts agree that *Rudapithecus* was a member of the *Dryopithecus* genus. Determination of the species, however, is quite uncertain. In some opinions, *Rudapithecus hungaricus* is in fact identical with *Dryopithecus brancoi* found in a similar age layer at Salmendingen in Germany during the past century (BEGUN and KORDOS, 1993). Others used the name *Dryopithecus carinthiacus* (ANDREWS, 1996). Naturally, only hypotheses are available on the question of what *Rudapithecus* really was. Comparisons performed by applying earlier and modern methods suggest that

Rudapithecus and the present chimpanzee must have been in close relation. *Dryopithecus* is the northern-most great ape, and represents, together with *Ouranopithecus*, a vicariant ecological pair to the later occurring African apes and humans (BEGUN, 1994).

In contrast with this theory is the experience that, throughout Europe, the links are missing that would indicate that successors of the whole *Dryopithecus* group could have survived. They probably formed an extinct line of evolution.

The most recent results of the *Dryopithecus* research from Rudabánya reveal that the cranial capacity of the female ape was 300-340 cm^3, the IQ was 2.9, the body size was 26.5 kg, and the height was 120-130 cm (KORDOS and BEGUN, 1996). The endocast of RUD-77 (female *Dryopithecus*) includes the complete frontal lobe, a large part of the right parietal lobe and some parts of the occipital lobe. The sulcal pattern is well preserved, and the endocast of RUD-77 exhibits a basically cercopithecoid pattern (KORDOS, 1993). *Dryopithecus* is a relatively generalized suspensory arboreal quadruped (BEGUN, 1993; KORDOS and BEGUN, 1996.). The bony labyrinth of *Dryopithecus* from Rudabánya (RUD-77) is similar to that of extant apes (SPOOR, 1996). Both the microwear and the shearing crest development of *Dryopithecus* dental remains suggest a more generalized frugivorous diet (UNGAR, 1996).

The enigmatic Rudabánya primate *Anapithecus hernyaki* was initially described by KRETZOI in 1974 as a new member of the family Pliopithecidae. Forty items, probably from 15 individuals, including one skull fragment and 176 teeth of this species, have been discovered up to the latest, 1994 field season at Rudabánya. The Rudabánya *Anapithecus* is a large catarrhine primate with a short and broad face and a highly vaulted neurocranium. The upper cheek teeth are characterized by premolars and molars not mesiodistally compressed. The lower dentition is characterized by elongated premolars; first and second molars with an asymmetric rhomboid or trapezoid shape; and an extremely elongated third molar with a very complicated stucture. *Anapithecus* differs in many respects from the genera *Pliopithecus, Epipliopithecus*, *Plesiopliopithecus*, *Laccopithecus* and *Crouzelia*. The origin of the genus is still unknown. Some other European localities are currently recognized as containing Anapithecus: Götzendorf (Austria), Salmendingen (Germany), Priay (France) and probably Eppelsheim (Germany) and Felsőtárkány (Hungary) (KORDOS, 1996).

Taphonomy, paleoecology and age of Rudabánya sites

The results of taphonomic investigations (ANDREWS et al., 1996a) indicate several modes of accumulation of animal bones at Rudabánya. Tree trunks and roots are present in growth positions in lignites, black muds and massive marls, and the fossil animal bones present show a lack of disturbance. Water transport is indicated for re-worked marls, with the animal bones affording evidence of preferred orientation in the direction of water flow. The accumulation of shelly layers and small mammal assemblages is associated with pond deposits accumulated on lake-shore flats. Little evidence of predation has been found in any level, but there is extensive post-depositional modification of the fossils from most levels, due to highly acid environments. The exception to this is the assemblage from the pond deposits, which, although heavily blackened, shows little other evidence of post-depositional modification.

The environment at Rudabánya has been reconstructed on the basis of community ecology theory (ANDREWS et al. 1996b). This compares the pattern of niche distribution in the fossil fauna with the range of patterns observed in mammalian faunas from present-day environments. Three morphological aspects of terrestrial ecosystems can be identified in mammalian fossils: the spatial niche is identified from a combination of locomotor adaptations and body sizes; the trophic niche is identified from dental and masticatory adaptations, again with a size element, although body size is less important than in the spatial niche; and body size alone is a major component of the multi-dimensional niche.

The taphonomic profile of the Rudabánya II fauna is complex, and palaeoecological reconstruction is not possible for all levels. In general, the mammalian fauna is most similar to subtropical forest faunas of the present-day, with complex tree canopies in a wet environment. There are similarities both with monsoon forest faunas present today in India and Burma, and with more seasonal tropical forest faunas of Africa. An equable climate may be indicated, but the sedimentological evidence indicating the presence of an abundant water supply may be due to edaphic or topographic circumstances, since the fossil deposits accumulated in a periodically flooded valley in which swamp, riverine and lake deposits alternated through time. The flora and fauna may be representative of this local environment, but the climate and vegetation outside the area of accumulation are difficult to reconstruct.

The sequence of fossiliferous sediments at the Rudabánya locality represent depositional environments associated with the Pannonian lake margin. These environments include deep lake sedimentation of marl, delta deposits, swamps, riparian alluvial systems and terrestrial soil development. The carbon isotope patterns of paleosol carbonates at Rudabánya are similar to those of modern soils developing under moderately continental climates (EKART and THEOBALD, 1996).

Paleomagnetic analysis of the Rudabánya sediments reveals very weak magnetizations with relatively low unblocking temperatures, suggesting pervasive overprinting by Fe-hydroxides, which precludes delineation of primary magnetic polarities. Laser-fusion 40Ar/39Ar dating of individual angular K-feldspar crystals separated from claystone immediately underlying the uppermost horizon yields a dominant mode at 11.4 Ma (RENNÉ et al., 1996).

Biochronologic assessments of the mammalian fauna are consistent with an MN9, early Vallesian age. The rodent fauna suggests a possible upper MN9 correlation. The hipparionine horses are advanced as compared to Pannonian D-E hipparions and the Hövwenegg (Germany) hipparion dated 10.3 Ma (BERNOR et al., 1993). Biochronologic considerations suggest a younger age which is constrained between 10.3 Ma and the MN9/10 boundary estimate (9.5 Ma). The age of the Rudabánya hominoid site is estimated to be ca. 10 Ma.

References

ANDREWS, P. (1996): Paleoecology of the Rudabánya II Miocene Fauna. In: BERNOR, R. L. and KORDOS, L. (eds): The Late Miocene Hominoid Locality of Rudabánya, Hungary. - Columbia University Press (in prep.).

ANDREWS, P., HARRISON, T., DELSON, E., BERNOR, R. L. and MARTIN, L. (1996a): Distribution and biochronology and southwest Asian Miocene Catarrhines. In: BERNOR, L. R., FAHLBUSCH, V. and MITTMANN, H.-W. (eds): The evolution of Western Eurasian Neogene mammal faunas. - Columbia University Press, 168-207 pp.

ANDREWS, P., ARMOUR-CHELU, M., CAMERON, D., GUNGOR, A., POLK, J. and ROSAS, A. (1996b): Taphonomy of the Rudabánya II Fauna. In: BERNOR, R. L. and KORDOS, L. (eds): The Late Miocene Hominoid Locality of Rudabánya. - Hungary (in prep.).

BEGUN, D. R. (1993): New catarrhine phalanges from Rudabánya (Northeastern Hungary) and the problem of parallelism and convergence in hominoid postcranial morphology. - J. Human Evol. *24*, 273-402.

BEGUN, D. R. (1994): Relations among the great apes and humans: new interpretations based on the fossil great ape *Dryopithecus*. - Yearbook Phys. Anthrop. *37*, 11-63.

BEGUN, D. R. and KORDOS, L. (1993): Revision of *Dryopithecus brancoi* SCHLOSSER, 1901 based on the fossil hominoid material from Rudabánya. - J. Hum. Evol. *25*, 271-285.

BEGUN, D. R. and KORDOS, L. (1996): The death assemblage of fossil catarrhines from Rudabánya (Hungary). - Am. J. Phys. Anthrop., Suppl. *22*, 67.

BERNOR, R. L., KRETZOI, M., MITTMANN, H-W. and TOBIEN, H. (1993): A Preliminary systematic assessment of the Rudabánya Hipparions (Equidae, Mammalia). - Mitt. Bayer. Staatsslg. Palaont. hist. Geol. *33*, 195-207.

EKART, D. and THEOBALD, G. (1996): Sedimentology and geochemistry of the Rudabánya II.- In: BERNOR, R. L. and KORDOS, L. (eds): The late Miocene hominoid locality of Rudabánya, Hungary. - Columbia University Press (in prep.).

KORDOS, L. (1993): The endocranial cast of the *Rudapithecus*. - Fondation Fyssen Report, (manuscript).

KORDOS, L. (1996): The Enigmatic Primate Anapithecus hernyaki from Rudabánya.- In: BERNOR, R. L. and KORDOS, L. (eds): The late Miocene hominoid locality of Rudabánya, Hungary. - Columbia University Press (in prep.).

KORDOS, L. and BEGUN, D. R. (1996): *Dryopithecus* cranial capacity and early hominid encephalization. - Nature (in prep.)

KRETZOI, M. (1974): Towards hominization. - Anthrop. Közlem. *18*, 121-128.

KRETZOI, M. (1975): New ramapithecines and *Pliopithecus* from the Lower Pliocene of Rudaánya in north-eastern Hungary. - Nature *257*, 578-581.

RENNÉ, P., BERNOR, R. L., KORDOS, L. and MÜLLER, P. (1996): Constraints on the Age of the Rudabánya Site. In: BERNOR, R.L. and KORDOS, L. (eds): The late Miocene hominoid locality of Rudabánya, Hungary. - Columbia University Press (in prep.)

SPOOR, C. F. (1996): The ancestral morphology of the hominoid bony labyrinth; the evidence from *Dryopithecus*. - Am. J. Phys. Anthrop., Suppl. *22*, 219.

UNGAR, P. S. (1996): A study of the diets of fossil Primates from Rudabánya.- In: BERNOR, R. L. and KORDOS, L. (eds): The late Miocene hominoid locality of Rudabánya, Hungary. - Columbia University Press (in prep.).

ACTA BIOL. SZEGED. 42, pp. 99-106 (1997)

NEW DATA ON THE AVAR PERIOD POPULATION OF THE VÁC REGION

B. G. MENDE

Archaeological Institute, Hungarian Academy of Sciences, H-1014 Budapest, Uri u 49., Hungary

(Received: December 10, 1996)

Abstract

The approximately 250 years spent by the ethnic groups of the Avar Empire in the Carpathian Basin created an almost inexhaustaible source of data for historical anthropology from methodological, typological and taxonomic points of view. Several cemeteries, dated to the 7th-8th centuries, are known from the area between the Danube and Tisza rivers. Mongolid-Europomongolid characteristics occur among their osteological materials. In spite of their small number, the graves excavated at the Vác 44 site clearly reflect the heterogeneity observed in hundreds of burials in cemeteries that were used until the Late Avar Period. The number of children is smaller than expected. Their absence is especially marked in the Infans II age group. The balanced gender composition and age distribution of the material can readily be interpreted in the older age groups. The material available for taxonomic studies is mixed. Europid elements dominate, but Mongolid-Chamaecranic and Sinid characters also occur.

Key words: palaeoanthropology, Avar Period, region between the Danube and Tisza rivers, Mongolid characters.

Introduction

In 1995, a segment of a cemetery was uncovered during the course of rescue work relating to road construction at the Vác 44 site. The excavations were carried out by employees of the Ignác Tragor Museum in Vác. According to the field director, archaeologist LÁSZLÓ SIMON, the graves represent a segment of a cemetery (possibly containing hundreds of similar burials) that may be dated to the Middle and Late Avar Periods. The restoration and analysis of the bone material was carried out in the Archaeological Institute of the Hungarian Academy of Sciences. Since the skeletons, and especially the crania, were poorly preserved, even the most meticulous restoration work could be aimed only at the reconstruction of the greatest possible number of measurements for the purposes of publication. It must be mentioned that the representative value of the data thus obtained is not sufficient for firm conclusions to be drawn concerning the population interred in the unexcavated parts of the cemetery. The heterogeneity of the picture that emerged during the evaluation is suggestive of the possibility that the entire population in this cemetery was similarly mixed, as is characteristic of cemeteries used until the Late Avar Period. Due to the limited length of this study, only the metric and morphological traits will be presented here. Further research will be required for an evaluation of the pathological phenomena and epigenetic characteristics.

Avar Period populations have been observed in several cemeteries in the Vác region. These include the sites at Váchartyán (BÁTAI, 1952; LIPTÁK, 1957, 1959; FERENCZY, 1963) and Vác-Kavicsbánya (GYENIS, 1968; FERENCZ, 1981). Anthropological materials from the region between the Danube and Tisza rivers have previously been classified from various points of view (WENGER, 1967).

Materials and methods

The excavated section of the cemetery contained the remains of 92 identifiable individuals. Skulls and postcranial parts were equally badly preserved. Detailed craniometric studies could therefore be carried out only on 14 men and 10 women. Of the long bones, data on 27 and 17 specimens, respectively, were available for estimations of stature.

The ages at death for adults were determined via the inner structure of the proximal epiphysis of the humerus (H) and femur (F), as well as the surface of the facies symphyseos ossis pubis (FS) (NEMESKÉRI et al., 1960). Evaluations were carried out in the system developed by SJØVOLD (1975). Patterns of toothwear (MILES, 1963; PERIZONIUS, 1981) and classification of the medial epiphysis of the clavicula in the 18-30-year age interval (SZILVÁSSY, 1978) were recorded as well. In the case of juveniles, an ossification table based on X-ray methodology (SCHINZ et al., 1952) was used. Epiphyseal closures tabulated by BROTHWELL (1981) and the recommendations of FEREMBACH et al. (1979) were additionally taken into consideration. In the case of children, tables of dental development were used (SCHOUR and MASSLER, 1941; UBELAKER, 1984). Measurable long bones were developed by using the method of STLOUKAL and HANÁKOVÁ (1978). Due to the poor preservation of the bones, in a number of cases (16), ages over 23 years were pooled in the 23-x category.

Sex determinations were carried out by using 22 characteristics (ÉRY et al., 1963), in addition to the description of sexual characteristics on the entire skeleton and skull and examination of the sulcus praeauricularis. In the case of juveniles, sexing was performed only when skeletal traits permitted a reliable appraisal. Whenever sexual characteristics were not available for study, sexing was attempted by using absolute measurements.

Morphometric studies of the skull and postcranial skeleton were carried out in the system developed by MARTIN (MARTIN and SALLER, 1957; in KNUSSMANN, 1992). Skull capacity was calculated following the method of PEARSON et al. (1903). Statures were estimated on the basis of tabulated data for both sexes and all races published by SJØVOLD (1990). Skulls were classified into the categories defined by ALEKSEYEV and DEBETS (1964), while work by LIPTÁK provided the basis for taxonomic analyses (FARKAS, 1972).

Results and discussion

The results concerning the age at death and the distribution of the sexes demonstrate that the number of children was less than usual (below 25%). The number of adults was small as well. Representatives of the mature age group, on the other hand, made up approximately one-third of all identifiable skeletons (even if the 23-x age determinations and the two transitional age groups are not included within the group of matures). The distribution of the sexes is balanced both in the entire section excavated and in its sub-divisions by age groups. This main trend of sex distribution is not even altered by the presence of some sixteen 23-x individuals who represent a broad range of age. The question remains, however, as to whether these data are valid for the entire cemetery. Therefore, they should not be uncritically extrapolated to the age and sex distributions of the entire population (Table 1).

Table 1. Distribution according to sex and age.

Age group	Males	Females	Uncertain	Together
Infans I	-	-	10	10
Infans II	-	-	7	7
Juvenis	1	2	1	4
Adultus	5	1	-	6
Maturus	18	11	-	29
Senilis	2	5	-	7
Ad-Mat.	2	4	-	6
Mat-Sen.	3	4	-	7
23 - x	4	11	1	16
Total	35	38	19	92

Due to the poor state of preservation, craniometric and morphological studies could be carried out on the skulls of only 14 men and 10 women. Since the resulting sets of data are incomplete, they do not sufficiently represent the entire series. Consequently, high range conclusions had to be avoided (Table 2).

Male skulls were mesocranic-brachycranic, ortho-hypsicranic and tapeinocranic-acrocranic even in the case of porion indices (20:1, 20:8). In terms of the frontal index, most foreheads were stenometopic and eurymetopic. The few indices of the facial part were hypereuryprosopic-euryprosopic, while the upper part was of euryene-mesene-leptene type. The orbitae were chamaeconch, while values of the nasal index were indicative of the chamaerrhine type. The cranial capacity was euen-aristencephalic. When the morphological traits were classified, the set of skulls was heterogeneous in both the norma verticalis and the norma occipitalis. A pentagonoid outline could be singled out as one of the main components, while shapes described as "bomb", "house" and "tent" could also be seen from the occipital aspect. The development of the glabella ranged between 3 and 5 on BROCA's classification, while the entire range of categories (1 to 5) could be observed in the case of the protuberantia occipitalis externa. In the individuals available for study, moderate and better expressed alveolar prognathia were also seen. The apertura piriforme, revealed an athropine nasal opening and sulcus praenasalis. The profile line of the occipital region was also heterogeneous. A curvo-occipital outline was the only noteworthy trait. Flattened lambda regions did not appear, or were present, but in a moderate form.

Female skulls fell into ALEKSEYEV's dolichocranic-mesocranic, orthocranic and acrocranic categories. They were metrio-eurymetopic in terms of frontal indices. As far as the skull capacity was concerned, the skulls of the women were euen- but mostly aristencephalic. An in sufficient number of data were available for characterization of the facial part. As regards the morphological traits of the norma verticalis, most skulls were ovoid and pentagonoid, while the norma occipitalis revealed the aforementioned tent and house shapes. The glabella scores were 2-3 on the BROCA scale, while the protuberantia occipitalis externa fell within the interval 1-3. The profile line of the occipital region was curvo-occipital or slightly curvo-occipital. Flattened lambda regions were unusual or are present only in a moderate form.

Table 2. The most important measurements and indices of the skull.

Martin no.	N	V	M	s	N	V	M	s
	MALES				FEMALES			
1	14	170—193	181.4	6.67	10	170—194	179.0	7.69
5	5	98—106	101.2	3.56	5	97—106	100.4	3.78
8	12	137—154	144.0	5.64	10	126—150	135.7	6.09
9	14	88—104	96.3	4.41	9	89—103	97.9	4.51
10	14	113—129	121.2	5.13	9	110—119	115.2	3.42
11	12	113—136	124.7	6.69	10	112—127	117.9	7.06
12	11	105—131	113.3	6.74	9	102—115	108.1	4.28
17	6	123—146	134.5	8.24	5	119—139	129.6	7.50
20	5	104—122	114.4	6.88	2	112—113	112.5	0.71
23	11	495—545	520.8	16.56	7	485—534	509.3	16.51
40	3	95—105	99.3	5.13	1	—	—	—
43	6	99—113	106.7	6.22	5	96—104	100.4	3.21
44	5	97—107	101.8	3.70	4	91—97	94.0	2.94
45	7	132—140	134.7	2.69	5	117—129	122.6	5.03
46	6	94—104	97.8	3.82	4	86—97	93.3	4.99
47	4	103—130	112.5	12.01	2	106—125	115.5	13.43
48	5	65—80	71.0	6.00	2	62—66	64.0	2.83
51	5	39—49	43.2	3.77	4	32—42	38.0	4.55
52	5	28—36	31.2	3.27	4	33—40	34.8	3.50
54	4	25—27	26.0	1.15	2	25—26	25.5	0.71
55	5	41—56	49.8	5.54	2	49—49	49.0	0.00
60	4	56—64	61.0	3.46	1	—	—	—
61	3	62—65	63.3	1.53	1	—	—	—
62	4	39—46	43.5	3.11	1	—	—	—
63	3	40—42	41.0	1.00	1	—	—	—
65	13	110—129	120.7	5.96	7	100—126	115.3	8.06
66	13	87—112	101.2	6.83	9	83—103	93.7	6.56
68	14	67—83	76.3	4.95	9	65—76	71.7	3.74
69	13	29—37	32.3	2.06	8	28—35	30.5	2.20
70	14	58—73	63.9	4.03	8	52—63	56.5	4.04
71	14	27—36	32.1	2.81	9	26—33	29.4	2.13
72	1	—	—	—	1	—	—	—
75	1	—	—	—	1	—	—	—
75/1	1	—	—	—	1	—	—	—
79	13	115—130	121.2	4.96	9	124—134	129.2	3.63
38	8	1298—1550	1471.3	87.19	7	1243—1380	1303.3	43.62
8 : 1	12	73.4—88.4	79.5	4.39	10	68.1—87.2	7.9	5.42
17 : 1	5	69.9—76.6	74.6	4.36	5	69.2—72.0	70.9	1.06
20 : 1	6	61.2—75.6	65.5	5.54	2	63.8—65.1	64.5	0.92
17 : 8	5	88.4—105.8	94.1	7.34	5	79.3—104.8	95.2	10.05
20 : 8	6	73.4—91.7	81.6	7.45	2	84.3—85.5	84.9	0.85
9 : 8	11	63.3—73.8	67.5	3.16	9	64.7—76.3	70.0	3.75
47 : 45	5	64.8—97.0	79.6	11.87	2	90.6—100.8	95.7	7.21
48 : 45	5	48.6—59.7	52.7	4.79	2	52.8—53.0	52.9	0.14
52 : 51	5	67.4—83.7	72.4	6.59	4	78.6—89.0	82.0	4.72
54 : 55	4	49.0—65.9	54.5	7.73	2	51.0—53.1	52.1	1.48
61 : 60	3	92.2—101.6	97.9	5.03	1	—	—	—
63 : 62	3	86.9—95.5	91.2	4.30	1	—	—	—

The measurements and indices of the skulls and the distribution of metric and morphological traits are listed in Tables 3 and 4.

Table 3. The distribution of craniometric characteristics.

Indices (Martin)***	Characteristics			Male	Female	Together
8 : 1	Hyperdolichocranic	65.0 - 69.9		-	2	2
	Dolichocranic	70.0 - 74.9		2	1	3
	Mesocranic	75.0 - 79.9		5	5	10
	Brachycranic	80.0 - 84.9		4	1	5
	Hyperbrachycranic	85.0 - 89.9		1	1	2
	Total:			12	10	22
17 : 1	Chamaecranic	x - 69.9		1	1	2
	Orthocranic	70.0 - 74.9		2	4	6
	Hypsicranic	75.0 - x		2	-	2
	Total:			5	5	10
20 : 1	Chamaecranic	x - 57.9		-	-	-
	Orthocranic	58.0 - 62.9		3	-	3
	Hypsicranic	63.0 - x		3	2	5
	Total:			6	2	8
17 : 8	Tapeinocranic	x - 91.9		3	1	4
	Metriocranic	92.0 - 97.9		1	-	1
	Akrocranic	98.0 - x		1	4	5
	Total:			5	5	10
20 : 8	Tapeinocranic	x - 79.9		3	-	3
	Metriocranic	80.0 - 85.9		1	2	3
	Akrocranic	86.0 - x		2	-	2
	Total:			6	2	8
9 : 8	Stenometopic	x - 65.9		5	1	6
	Metriometopic	66.0 - 68.9		2	3	5
	Eurymetopic	69.0 - x		4	5	9
	Total:			11	9	20
47 : 45	Hypereuryprosopic	x - 79.9		2	-	2
	Euryprosopic	80.0 - 84.9		2	-	2
	Mesoprosopic	85.0 - 89.9		-	-	-
	Leptoprosopic	90.0 - 94.9		-	1	1
	Hyperleptoprosopic	95.0 - x		1	1	2
	Total:			5	2	7
48 : 45	Euryene	45.0 - 49.9		2	-	2
	Mesene	50.0 - 54.9		1	2	3
	Leptene	55.0 - 59.0		2	-	2
	Total:			5	2	7
52 : 51	Chamaekonch	x - 75.9		4	-	4
	Mesokonch	76.0 - 84.9		1	3	4
	Hypsikonch	85.0 - x		-	1	1
	Total:			5	4	9
54 : 55	Leptorrhine	x - 46.9		-	-	-
	Mesorrhine	47.0 - 50.9		1	-	1
	Chamaerrhine	51.0 - 57.9		2	2	4
	Hyperchamaerrhine	58.0 - x		1	-	1
	Total:			4	2	6
38		Male	Female			
	Oligencephalic	x - 1300	x - 1150	1	-	1
	Euencephalic	1301 - 1450	1151 - 1300	2	4	6
	Aristencephalic	1451 - x	1301 - x	5	3	8
	Total:			8	7	15
Stature		Male	Female			
	small	150.0 - 159.9	140.0 - 148.9	4	2	6
	small-medium	160.0 - 163.9	149.0 - 152.9	4	5	9
	medium	164.0 - 166.9	153.0 - 155.9	6	4	10
	tall medium	167.0 - 169.9	156.0 - 158.9	5	3	8
	tall	170.0 - 179.9	159.0 - 167.9	7	3	10
	Total:			26	17	43

*** Indices 61: 60 and 63 : 62 are not shown due to the small sample size.

Table 4. The distribution of craniomorphological characters.

Characteristics		Male	Female	Together
Norma verticalis	ovoid	—	2	2
	pentagonoid	3	2	5
	spheroid	2	—	2
	ellipsoid	1	—	1
	ovoid-pentagonoid	4	5	9
	ovoid-ellipsoid	1	1	2
	pentagonoid-spheroid	2	—	2
	Total:	13	10	23
Norma occipitalis	bomb	5	2	7
	house	4	2	6
	tent	4	6	10
	Total:	13	10	23
Glabella	Broca 1	—	1	1
	Broca 2	1	7	8
	Broca 3	6	2	8
	Broca 4	4	—	4
	Broca 5	2	—	2
	Total:	13	10	23
Protuberantia occipitalis externa	Broca 0	—	1	1
	Broca 1	2	6	8
	Broca 2	6	3	9
	Broca 3	2	—	2
	Broca 4	1	—	1
	Broca 5	2	—	2
	Total:	13	10	23
Fossa canina	1. filled up	2	—	2
	2. shallow	1	1	2
	3. moderate	1	—	1
	4. deep	—	1	1
	5. very deep	1	—	1
	Total:	5	2	7
Spina nasalis anterior	Broca 3	1	1	2
	Broca 4	3	—	3
	Total:	4	1	5
Prognathia alveolaris	2. moderate	2	—	2
	3. marked	2	1	3
	Total:	4	1	5
Apertura piriforme	2. fossa praenasalis	3	1	4
	3. anthropine	2	1	3
	Total:	5	2	7
Occipital arch	1. bathrocranic	3	—	3
	2. curvo-occipital	5	8	13
	3. moderately curvo-occipital	4	2	6
	4. planoccipital	1	—	1
	Total:	13	10	23
Flatness of the lambda region	1. none	6	2	8
	2. moderate	5	8	13
	3. marked	1	—	1
	Total:	12	10	22

SJØVOLD'S tabulated estimates based on the long bones of the postcranial skeleton revealed a heterogeneous picture for the statures of both men and women. The majority of the men were medium, medium tall or tall, while variants of medium stature dominated among the women. This may be due to the fact that only in a very few cases was it possible to carry out calculations using all six long bone measurements recommended by SJØVOLD. In terms of body proportions, the claviculo-humeral and radio-humeral indices were homogeneous for the men. On the other hand, the tibio-femoral indices were indicative of eurysome and normosome lower leg formations. Due to the small sample size, only this latter extremity segment could be characterized for the women. Similarly as for the legs of the men, the indices pointed to relatively short, but well-proportioned lower legs.

Five men's skulls were available for purposes of taxonomic analysis. It was only in these cases that almost the entire neurocranium and viscerocranium were available for measurement and morphological description. Skull 36 showed Sinid characters, and Skull 61 show Inner-Asiatic Sinid traits. Among the Europid types, Skull 80 represented the brachycranic group with strong Alpine and reduced Cromagnoid-A characters. Skull 108 was dolichocranic, although it did not have a narrow face. He also displayed Nordoid and Cromagnoid-A elements. Skull 121 appeared most complex from a taxonomic point of view. It resembled a mixture between acrocranic, eurymetopic and perhaps Nordoid and Atlantomediterranean characteristics.

Conclusions

The excavated section of the Vác 44 cemetery was used between the late 7th and the early 9th centuries. The investigations carried out to date support observations that the material from cemeteries starting in the Middle Avar Period onwards usually contains remains of a heterogeneous population in the region between the Danube and Tisza rivers and also in Transdanubia. Naturally, due to the small size of the data set under discussion here, this trend can be generalized to only a limited extent. Ages at death are indicative of a relatively old population, with balanced sex ratios in all age groups. Mongolid elements occur and two of the few skulls available for taxonomic study show mixed characters. Some Mongolid types in the nearby Váchartyán cemetery are dolichocranic (Baikal type; LIPTÁK, 1959). No similar type was found at Site 44. At the same time, the brachycranic component at Váchartyán is Europo-mongolid, and brachycrania at 44 is accompanied by Sinid and Inner-Asian traits. The chamaecrania observed in the cemetery at Vác - Kavicsbánya is manifested in the form of Europid low skull formation but only two skulls display Mongolid characters. A combination of dolicho-mesocran Cromagnoid-A and Mediterranaen characters occurs in all three cemeteries. Nordoids and Europid brachycrans, the main components described from Vác - Kavicsbánya (the geographically closest cemetery), do not appear as independent types at Vác 44. The small sample size did not permit subdivision into smaller groups on either a metric or a morphological basis. Only the skull capacity allowed the population structure to be considered homogeneous.

References

ALEKSEYEV, V. P. and DEBETS, G. F. (1964): Kraniometrija. Metodika antropologicseszkij isszkledovnij. - Izdatelsztvo Nauka, Moszkva, 112-127 pp.

B. BÁTAI, E. (1952): A váchartyáni avar temető csontvázleleteinek embertani vizsgálata. - Ann. Hist.-nat. Mus. Nat. Hung. *2*, 213-224.

BROTHWELL, D. (1981): Digging up bones. The Excavation, treatment and study of Human Remains. - British Museum, London, 51-69 pp.

ÉRY, K., KRALOVÁNSZKY, A. and NEMESKÉRI, J. (1963): Történeti népességek rekonstrukciójának reprezentációja. - Antrop. Közl. *7*, 41-90.

FARKAS, Gy. (1972): Antropologiai praktikum I. Paleoantropologiai metodikák. - JATE, Szeged, 28-136, 200-216 pp.

FEREMBACH, D., SCHWIDETZKY, I. and STLOUKAL, M. (1979): Empfehlungen für die Alters- und Geschlechtsgiadnose am Skelett. - Homo *30*, 2. 1-32.

FERENCZ, M (1981): Some data to the palaeoanthropology of the Avar Periods population in Hungary. - Anthrop. Hung. *17*, 23-64.

FERENCZY, L. (1963): A váchartyáni avar kori temető. - Arch. Ért. 84-107.

GYENIS, Gy. (1968): Die Untersuchung des anthropologisches Materials des Vácer Gräberfeldes ausden VIII-IX. Jahrhunderten - Annales Univ. Sci. Bud. de Rolando Eötvös nom., Sec. Biol. *9-10*, 151-188.

KNUSSMANN, R. (1992): Anthropologie. Handbuch der Vergleichenden Biologie des Menschen. II. Allgemeine Anthropologie. - Stuttgart, Jena, New York

LIPTÁK, P. (1957): Awaren und Magyaren im Donau-Theiss Zwischenstromgebiet (Zur Anthropologie des VII-XIII. Jahrhunderts). - Acta Arch. Hung. *7*, 199-268.

LIPTÁK, P. (1959): The "Avar Period" Mongoloids on Hungary. - Acta Arch. Hung. *10*, 251-279.

MARTIN, R. and SALLER, K. (1957): Lehrbuch der Anthropologie. - Gustav Fischer Verlag. Stuttgart.

MILES, A. E. W. (1963): The Dentition in the assessment of individual age in skeletal material. In: BROTHWELL (ed.): Dental Anthropology Symposium Soc. Study Human Biology 5, 191-209.

NEMESKÉRI, J., HARSÁNYI, L. and ACSÁDI, Gy. (1960): Methoden zur Diagnose des Lebensalters von Skelkettfunden. - Anthrop. Anz. *24*, 71-88.

PEARSON, K., JACOB, S. and LEE, A. (1903): Craniological notes. - Biometrika *2*, 338.

PERIZONIUS, W. R. K. (1981): Diachronic dental research on human skeletal remains excavated in the Netherlands I. - Berichten van de Rijksdienst voor het Oudheidkundig Bodemaderzoek. *31*, 369-413.

SCHINZ, H., BAENSCH, W., FRIEDL, E. and UEHLINGER, E. (1952): Lehrbuch der Röntgen-Diagnostik. 5.Ausgabe 1-4. Stuttgart.

SCHOUR, I. and MASSLER, M. (1941): Development of Human dentition. - J. Am. Dent. Assoc. *28*, 153-1160.

SJØVOLD, T. (1975): Tables of combined method for determination of age at death given by NEMESKÉRI, HARSÁNYI and ACSÁDI. - Anthrop. Közl. *19*, 9-22.

SJØVOLD, T. (1990): Estimation of stature from long bones utilizing the line of organic correlation. - Human Evolution *5*, 431-447.

STLOUKAL, M. and HANÁKOVÁ, H. (1978): Die länge der Längsknochen altslawischer Bevölkerungen unter besonderer Berücksichtigung von Wachstumsfragen. - Homo *29*, 53-69.

SZILVÁSSY, J. (1978): Ein Method zur Altersbestimmung mit Hilfe der sternalen Gelenckflachen der Schlüsselsbeine. - Mitt. Anthrop. Ges. *61*, 1-28.

UBELAKER, D. H. (1984): Human Skeletal Remains. Excavation, analysis, interpretation. - London

WENGER, S. (1967): Adatok az avarkor népességének antropológiájához. - Anthrop. Közl. *11*, 199-215.

ACTA BIOL. SZEGED. 42, pp. 107-112 (1997)

MUMMIES FROM THE 18TH -19TH CENTURY DOMINICAN CHURCH OF VÁC, HUNGARY

I. PAP[1], É. SUSA[2] and L. JÓZSA[3]

[1]*Department of Anthropology, Hungarian Natural History Museum, H-1062 Budapest, Bajza u. 39.;*
[2]*Forensic Institute, Budapest, H-1363 Budapest, P.O.B. 31, Hungary;*
[3]*Department of Morphology, National Institute of Traumatology, H-1430 Budapest. POB. 21, Hungary.*

(Received: January 20, 1997)

Abstract

A large series of well-documented, naturally mummified individuals came to light during reconstruction work at the Dominican Church in Vác, Hungary in 1994-95. 265 individuals were buried in the crypt, and the remains of approximately 40 individuals' were contained in the ossuary. Citizens of the flourishing small town of Vác and some clericals were buried here, a detailed register of them was kept in the rectory. The very poor, but continuous ventilation through two long, narrow tunnels, and the protection against humidity provided by coffins being stacked in layers helped to preserve the anthropological and ethnographic material of the crypt.

Key words: 18th-19th century, Dominican Church, Vác, naturally mummified bodies, ossuary.

Introduction

A large series of well-documented, naturally mummified individuals came to light in Hungary recently. In 1994-95 reconstruction work was in progress at the Dominican Church in Vác. The Dominicans historically specialized in health care and built and ran a considerable number of hospitals throughout their history. The church is still active, though it has had no connection with the Dominicans for two centuries now.

The construction of the church started in 1699. It gained the name Church of the White after the colour of the Dominican cowl. The crypts situated in its undercroft were a later development. Though the church was consecrated in 1713, the crypts were utilized for burials continuously only from 1731 until 1838, i.e. for more than a century.

Citizens of the flourishing small town of Vác and also some clericals were buried here; a detailed register of them was kept in the rectory.

Description and exposure of the site

In the 1990s the crypts had to be reconstructed. During the reconstruction, the Diocese gave permission to the Tragor Ignác Municipal Museum in Vác to explore the contents of the crypt. Work started at the end of November, 1994 and was executed in two phases. The first phase ended in early February 1995, and the second phase was a 10-day period of work in May 1995. The team was based on the staff of the Tragor Ignác Municipal Museum and was led by two ethnographers, MÁRTA ZOMBORKA and EMIL RÁDULY (Open-Air Museum of Szentendre). One of the present authors, ÉVA SUSA (Forensic Institute, Budapest), was the anthropologist member of the team. Unfortunately, the team had no archaeologist and therefore could not benefit from the methodical and practical knowledge of an expert familiar with the discovery of findings under similar circumstances. This unfortunate situation was brought about by the traditional division of labour in Hungarian museums. Archaeologists deal with findings up to the end of the 17th century, and anything after that time is the responsibility of ethnographers.

The crypts were the traditional burial site for a number of middle-class families. Painted and ornamented coffins were placed in rows, and the next layer was then placed on the coffins in the floor layer. Three and sometimes four layers of coffins were built up in the sequence of burials. The place was quite frequently visited, probably on holidays, by living family members. At the end of the 18th century, the emperor, Josef the Second, introduced a torrent of enlightened reforms. He banned almost all monastic orders by virtue of their laziness and waste of human effort, but a further of his regulations concerned burial habits in detail. One of his regulations forbade the practice of crypt burials and prohibited any further visits to such sites by anyone. However, the locals adhered to their traditions and a good number of burials were carried out in this way in the following decades as well. Finally, the steps leading to this crypt were bricked up in 1838 and these crypts were gradually forgotten.

The first crypt comprised a sizeable hall approximately 8 m long by 10 m wide, with a regular ground plan. It is approximately 4 m deep. In the middle, there is a strong pillar supporting some finely arched brick ceiling elements. A small corridor leads to a cavity containing an ossuary. The cavity was closed, more or less sorrounded by Medieval wall remains that are older than the present church. The size and shape of the cavity are quite unusual: It is 5 m long by 1 m wide at one end, but only 80 cm wide at the other. A large wooden box was precisely tailored into this place to contain the ossuary remains.

The first crypt (crypt I) has two small tunnels with a rectangular cross-section slightly slanting towards the surface. One of them runs up to the present surface. The other one probably connected the crypt to another, smaller underground crypt hall (crypt II). During the second phase, 110 individuals were discovered in the smaller hall, as access to it was gained through a hole drilled into its ceiling. The present church did not preserve any doors or steps leading into this place. The purpose of the small tunnel connecting the two crypts is not evident yet.

The two tunnels never provided access to crypt II after it was closed off by a wall, as both tunnels measure 60 × 30 cm. The tunnel connecting the two halls was also filled in with sand. These tunnels never provided sufficient air exchange with the outside world. The excavation process was started from dismantling part of one of the outer walls of the church. Steps were revealed behind this wall and these provided access to the large crypt hall and hence to the ossuary. These steps must have been the original way into the crypt (ZOMBORKA, 1996).

Climatic examinations

Following the first phase of the excavation process, the Hungarian Natural History Museum asked the Meteorology Department of Eötvös Lóránd University, Budapest to establish the climatic conditions in the crypt. One aspect was to establish the original microclimate that preserved the mummies. The other aspect was a very practical one. We needed guide-lines for the preservation of the findings. Climatic measurements were taken days before the second phase of the excavation and they lasted for a week in May. It was concidered that the opening of the crypt could not bring about decisive changes in its microclimate after a hundred years of regular burials and visits. The door of the undercroft had stood open quite frequently in all seasons without any deteriorating effects. There is no significant difference in the degree of mummification of the early and late buried individuals. The temperature and humidity exhibited only negligible variations and there is no reason to suppose that another season could have produced different values. While the outside temperature changed by 20 degrees during that week, the air temperature inside the crypt was virtually constant. The humidity too failed to follow the changes in the outside humidity.

The air temperature was measured at six sites in the empty crypt. The humidity was sampled at three sites, and the air pressure and air movement at one site each. Instruments were set up and the entrance was then bricked up again to establish conditions similar to the original ones. Traditional instruments (rotary termograph, hygrograph and barograph), and high-performance instruments (Rustrak humidity and temperature register and Dantec thermoanemometer) were used. All the instruments underwent calibration checks before the experiment.

The following climatic parameters were determined:

The temperature varied between 8 and 11 °C and there was no connection with the height of the measurement. The average 10 °C was practically constant, and falls into the range for most known caves and large underground cavities in Hungary. As the crypt had been closed down so long, it must have assumed the average underground temperature of its surroundings, as spring-water and natural caves do. This average for the 90 known natural caves in Hungary is 10 °C.

The relative humidity was found to be 90%.

This high humidity was very surprising. At such a humidity, fast decay might have been expected and not mummification.

The conditions in the crypt were determined by the complicated interaction of a number of factors. As the coffins were stacked in 3 and 4 layers, this layering prevented the formation of a unified microclimate and restricted humidity and local air motion changes. As most of the humidity originated from the soil, the coffins in the higher layers were subjected to much less humidity. The individuals in the higher coffins therefore were much better preserved.

Speleologists recently postulated the occurance of negative ionization in underground spaces, which might promote disinfection of the air in such places.

The air pressure reflected the outside air pressure: 991-1009 hPa.

The air motion was slight. Its average value was negligible.

Overall, it may be stated that the very poor, but continuous ventilation through the long, narrow tunnel, and the protection against humidity provided by the coffins being stacked in layers, helped to preserve the anthropological and ethnographic material in the crypt.

Conservation process

In work with mummies, it is always necessary to pay attention to fungi and other microorganisms.

Contact with mummies was restricted to that most necessary before fungial analyses were carried out. Breath-protection masks and gloves were used as a routine.

Microbiological samples were taken from the surfaces of the bodies. Their investigation did not demonstrate any sign of bacterial or fungial contaminations. Only the presence of some *Clostridium* sp., aerosporatic bacteria and ordinary mildew were found.

As no poisonous fungi were present, 3-minute X-ray (4.5 mA 75 kV/90 kV) doses were applied (SUSA et al., 1996).

The remains associated with each coffin number were stored in paper wrapping within wooden storage crates. After unpacking, all remains were superficially cleaned by vacuum cleaner.

Surfaces were rubbed with pure alcohol.

Anthropological material

The remains were naturally mummified. No trace of any artificial mummification technique could be found on any of the individuals.

They were all intact, with mummified intestines. Traces of medical dissectioning were evident in some individuals. One of them was a 10-year-old girl, (with a Y-shaped cut on her chest and an X-shaped cut on her abdominal region. The other was a young adult man (20 years old); his skull had been opened by the regular medical method. He also had a cross-shaped cut on his chest, that has been sewn up later, during the sectioning process. Both of these cases provide evidence of 18th-century medical practices, none of which have anything to do with mummification.

Seventy per cent of all those buried were more or less mummified, while a number of the buried individuals were skeletalized.

Distribution of individuals buried in the crypt

265 individuals were buried in the crypt and the ossuary contained the remains of approximately 40 individuals.

There were 71 males and 77 females (148 altogether) whose ages at the time of death were known. There were 55 individuals of known sex, but unknown age. There were 24 individuals of known age but unknown sex. There were 38 individuals of unknown age and sex.

The age varied between 0 and 94 years.

The coffins bore many written data, including names, ages, and date of death. These, combined with the church register and/or with all the dresses, provided a database for establishment of the names, and of course the sex and ages of the individuals.

As no anthropological estimation of sex and age has been carried out yet, this distribution was based only on the register of the excavation process. Although 265 individuals is not a large sample, and they represented only some of the wealthier families, we believe that they reflect a more or less random sample of the Vác population. The crypts pose a great challenge as concerns the establishment of demographic patterns.

The men had a life expectancy of 44.62 years at birth, and the women an expectancy of 38.84 years. In 1900, the national average of the life expectancy at birth for males and females was 40 years. Life expectancy at the age of 20 was almost the same for both sexes: 33-34 years. In 1900, the national average of these values, for males and females, was 45 years in Hungary.

These data are of interest as concerns the advances in medicine and infant and maternal mortality that are held so dear nowadays. It seems that the low level of urbanization, and the slow but continuous economic growth in the 18th century, produced much better life expectancies than in modern times. This is all the stranger if we remember that Hungary participated in the continuous wars with the Prussia of Frederick the Great and later in twenty years of wars with revolutionary France and Napoleon.

Acknowledgement

The study was performed in part with the support of Hungarian National Cultural Found (grants No. 014756-04/1995) and National Scientific Research Foundation (OTKA No. T 020323).

References

SUSA, É., PAP, I. and JÓZSA, L. (1996): A váci múmiák antropológiai vizsgálata (Mummies from the 18th-19th Century, Hungary). – Magyar Múzeumok *2(1)*, 14-16.

ZOMBORKA, M. (1996): Vác, "Fehérek temploma" kriptafeltárás 1994-95 (The Exposure of the Dominic Crypt in Vác, the initial stages of the restoration). – Magyar Múzeumok *2(1)*, 3-7.

ACTA BIOL. SZEGED. 42, pp. 113-122 (1997)

PALEORADIOLOGIC STUDY OF A 17TH CENTURY CASE OF TREPONEMATOSIS (NYÁRLŐRINC, HUNGARY)

GY. PÁLFI[1,3], M. PANUEL[2,3] and E. MOLNÁR[1]

[1]*Department of Anthropology, József Attila University, Szeged, P. O. B. 660, H-6701 Hungary;*
[2]*Service d'Imagerie Médicale, CHU Nord, Université de la Méditerranée, 13326 Marseille Cedex 15, France;*
[3]*Laboratoire d'Anthropologie Biologique, Faculté de Médecine de Marseille, UMR 6578 CNRS/Université de la Méditerranée, 13385 Marseille Cedex 5, France.*

(Received: December 10, 1996)

Abstract

This study deals with a female skeleton in a good state of preservation found in grave no 330 in the medieval cemetery at Nyárlőrinc. The grave can be dated to the 17th century. Macroscopic morphologic and paleoradiologic studies (X-ray and computed-tomographic analyses) have been carried out. The individual has widespread, bilateral and symmetrical florid periostitis, especially of the humeri, tibiae and femora. Similar lesions can be detected on the forearm bones, clavicles, scapulae, fibulae and calcanei. Periosteal new bone formation is associated with osteolytic areas and cortical deformities in several locations. Osteolytic changes of the sphenoid are to be mentioned. Traces of clustered pits can be recognized on the frontal and right zygomatic, which recall the first stage of contiguous gummatous osteoperiostitis. Macroscopic, radiologic and CT investigations of the cranial and postcranial alterations support the diagnosis of treponemal disease. The differential diagnosis and geographic situation suggest that the individual may have been suffering from acquired syphilis. The aim of this work is to attract attention to the possibility of identification of syphilitic lesions in uncommon locations and to the usefulness of paleoradiologic investigations during the diagnosis of treponemal diseases in ancient bones. The publication of complete cases in a good state of preservation can help further paleopathologic studies.

Key words: paleopathology, paleoradiology, 17th century, treponematosis.

Introduction

Within the group of specific infectious diseases, treponemal and mycobacterial infections can produce relatively characteristic skeletal lesions (HACKETT, 1976; STEINBOCK, 1976). While tuberculosis and leprosy produce, in general, morphologically and radiologically distinguishable changes, a distinction between the different forms of treponematoses is more difficult and often impossible.

The three types of *Treponema*, which can produce osteoarticular alterations in man, already classified as independent species, are actually brought together as three subspecies: *Treponema pallidum ssp. pallidum* (causative agent of venereal syphilis);

Treponema pallidum ssp. pertenue (agent of yaws, non-venereal) and *Treponema pallidum ssp. endemicum* (bejel, endemic syphilis, non-venereal) (GRIMPREL, 1993; MARTIN, 1993). These agents belong among the few pathogenic bacterial species that cannot be cultured *in vitro*. It is important to mention the inability to distinguish between bejel, syphilis and yaws microbiologically, biochemically, histologically, immunologically, or even with sophisticated DNA techniques (NOORDHOEK et al., 1990; GRIMPREL, 1993). Therefore, the clinical and epidemiological contexts preserve major importance in the diagnosis.

The situation is perhaps more critical in paleopathology. As the great majority of cases provide only skeletal materials for the examination, among the different types of clinical manifestations only the osteo-articular changes can be taken into consideration during the retrospective diagnosis. Fortunately, skeletal changes due to treponemal infections are clearly described in the pathologic, radiologic or paleopathologic literature (e. g. HACKETT, 1976; STEINBOCK, 1976; ORTNER and PUTSCHAR, 1985; VICENS et al., 1987; RESNICK and NIWAYAMA, 1988; EDEIKEN et al., 1990; MARCOVE and ARLEN, 1992; BAHK, 1994; LAGIER et al., 1994). In typical acquired or late congenital syphilis, morphologic (macroscopic or microscopic) and X-ray analyses reveal disseminated periosteal reactions, with thickening of cortical bone (with most frequent involvement of the tibia), and gumma formation (frequently in the skull), either in the cortex or in the spongiosa, accompanied by extensive proliferation. In yaws, osteitis and periostitis resemble syphilitic changes of bone. Destructive gummatous changes result in bone absorption and even pathologic fractures (EIDEKEN et al., 1990). The bone lesions of bejel are identical to those found in venereal syphilis, differing only in the relative frequency of various types of lesions (STEINBOCK, 1976). The pathologic and radiologic literature indicate that, in general, apart from the typical skeletal symptoms of early congenital syphilis (NABARRO, 1954; PANUEL, 1994), the sole characteristic in venereal syphilis, we cannot distinguish the osseous manifestations of the three diseases in the osteologic samples (VICENS et al., 1987; DUTOUR et al., 1994; LAGIER et al., 1994).

The geographic and epidemiologic context and the skeletal pattern of the lesions can suggest a hypothesis concerning the type of the treponemal infection, but never certitudes in paleopathology. Accordingly, the recent attempt by ROTHSCHILD and ROTHSCHILD (1995; 1996) to distinguish the three forms of treponematoses in osteoarchaeologic samples seems hazardous. To be able to compare large samples of treponemal cases at a population level, we need hundreds of well-preserved and correctly diagnosed cases per population (i. e. thousands of well-preserved skeletons of individuals who could have lived in the same area and in approximately the same period). In fact, skeletal samples are not so abundant and the paleopathologist discovers relatively small numbers of cases, which are always incomplete and fragmentary, and where it is always difficult to establish the diagnosis of the treponemal disease. We consider that the publishing of complete osteoarchaeologic cases of treponematoses and their morphologic and radiologic diagnosis, can help researchers in studies and diagnoses of paleopathologic lesions in more fragmentary skeletal material.

Materials and methods

The subject of our observation is a well-preserved skeleton found in grave no 330 in the cemetery at Nyárlőrinc (central Hungary). The cemetery, which was excavated under the direction of GYÖRGY SZÉKELY (archeologist of the Katona József Museum in Kecskemét), was used between the 14th and 18th centuries (H. TÓTH, 1990). The grave in question can be dated to the 17th century approximately (SZÉKELY, personal communication).

We discovered the pathologic lesions of this skeleton during the storing and classification of the anthropological series in the collection of the Department of Anthropology at József Attila University. The sex and age at death of the skeleton were determined by means of traditional methods used in historical anthropology (KNUSSMANN, 1988). Following a macroscopic morphologic study, a detailed radiologic and computed-tomographic analysis of the skeleton was carried out at the Service d'Imagerie Médicale, CHU Nord, Université de la Méditerranée, Marseille. Both the clinical and the paleopathologic special literature (e. g. HACKETT, 1976; ORTNER and PUTSCHAR, 1985; VICENS et al., 1987; RESNICK and NIWAYAMA, 1988; EDEIKEN et al., 1990) were used for differential diagnosis.

Results and discussion

The young adult female skeleton (age at death: 20 to 30 years) displays multiple abnormal bone changes. These abnormalities consist of both proliferative and destructive lesions, with evidence of the body's attempts at repair and remodeling. The characteristics of the observed bone lesions on the skeleton indicate that the disease process was active at the time of death.

Fig. 1. Traces of clustered pits on the frontal and nasal bones (photo by GY. PÁLFI).

Traces of clustered pits can be recognized on the frontal (Fig. 1) and nasal bones, and the right zygomatic. The radiographic plain-film of the skull presents lytic lesions on the frontal bone (Fig. 2). The CT of the skull shows small lytic areas on the outer table of the frontal region. The inner table is intact (Fig. 3). As concerns the base of the skull, osteolytice changes of the sphenoid are to be mentioned. Periosteal reactions and areas of focal destruction are seen on the vertebral borders of both scapulae.

Fig. 2. X-ray picture of the skull presenting small lytic lesions on the frontal bone (X-ray by M. PANUEL).

The individual has widespread, bilateral and symmetric florid periostitis, especially of the humeri, tibiae and femora. Similar lesions can be detected on the forearm bones, clavicles, scapulae, fibulae and calcanei. Figure 4 presents the periosteal appositions and small areas of focal destruction on the distal diaphyseal and metaphyseal regions of the humeri. Radiological investigations of the humeri reveal subtle lytic areas associated with cortical thickening of the middle-third of the diaphysis. The periosteal appositions and cortical remodeling are well presented by the lateral view radiograph of the right humerus (Fig. 5).

Both femora exhibit extensive osteoproliferative lesions. CT examination of the femurs has been carried out (Fig. 6). The transverse CT scan of the affected region reveals a small round lytic area and a "double-layer" appearance, with a thick periosteal reaction and relative thinning of the cortex. The AP radiograph shows cortical thickening with periostitis and some radiolucent foci of cortical destruction (Fig. 7).

Fig. 3. CT picture of the skull: small lytic areas can be observed on the outer table of the frontal region (CT by M. PANUEL).

Fig. 4. Periosteal appositions and small areas of focal destruction on the distal diaphyseal and metaphyseal regions of the humeri (photo by GY. PÁLFI).

Fig. 5. Lateral view radiograph of the right humerus: the periosteal appositions and cortical remodeling are to be mentioned (X-ray by M. PANUEL).

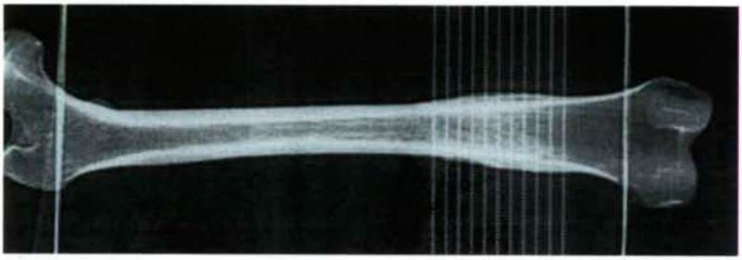

Fig. 6. CT analysis of the right femur (CT by M. PANUEL).

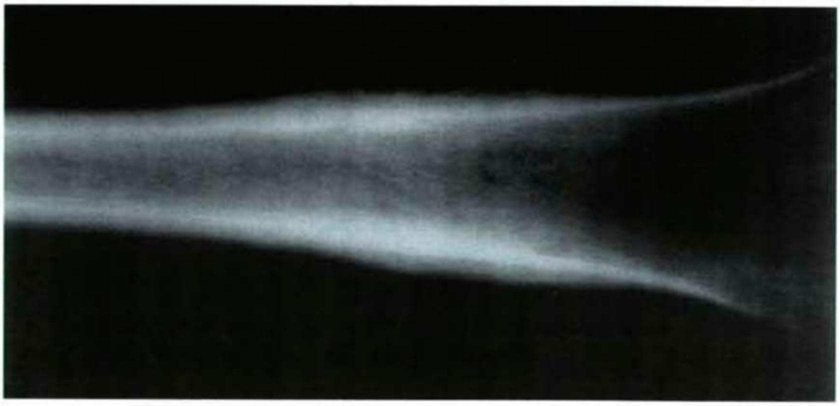

Fig. 7. AP radiograph of the right femur showing cortical thickening with periostitis (X-ray by M. PANUEL).

The tibiae and fibulae are both affected by the pathologic process. The macroscopic picture shows irregular periostitic hyperostosis (Fig. 8). The AP radiograph of the left tibia reveals cortical sclerosis of the diaphysis with periostitis (Fig. 9).

The positive lesions (periosteal appositions, cortical remodelling, etc.) must be regarded as indisputable *in vivo* processes. The paleopathologic interpretation of the osteolytic lesions is more difficult. However, these processes are, in all cases, associated in the same area of the bone with periostitic lesions and are characterized by sclerotic margins.

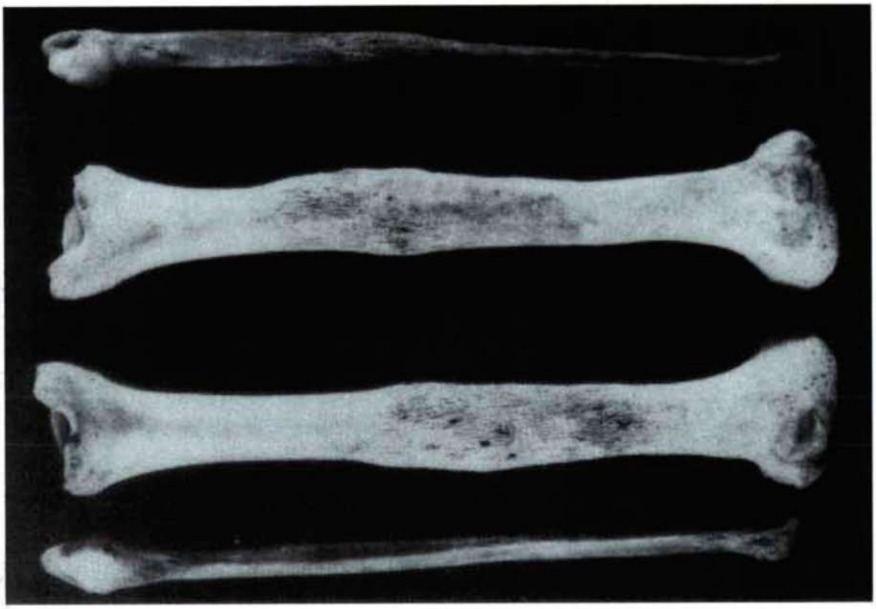

Fig. 8. Macroscopic picture of tibiae and fibulae, showing periostitic hyperostosis and osteolytic lesions (photo by GY. PÁLFI).

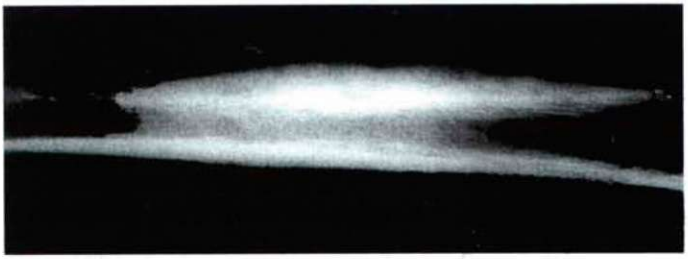

Fig. 9. AP radiograph of the left tibia, which reveals cortical sclerosis of the diaphysis with periostitis and focal areas of bone destruction (X-ray by M. PANUEL).

The picture of the above lesions is that of a generalized skeletal infection. The cranial lesions recall the first stage of contiguous gummatous osteoperiostitis (HACKETT, 1976). The macroscopic, radiologic and CT investigations of the cranial and postcranial alterations support the diagnosis of a treponemal disease (ORTNER and PUTSCHAR, 1985; VICENS et al., 1987; LAGIER et al., 1994).

Conclusions

Our 17th century subject suffered from a disseminated treponemal disease. On the basis of the pathologic and radiologic literature, the skeletal pattern of the involvement suggests that the young adult woman may have been affected by acquired syphilis (EIDEKEN et al., 1990; MARCOVE and ARLEN, 1992; BAHK, 1994). As concerns the geographical context, the temperate climatic zone seems to be more favorable for the venereal form of infection than for a non-venereal one. On the other hand, we already have some medical historical and paleopathologic data from the Hungarian Plain prior to this period (MARCSIK, 1994). Acquired syphilis appears to be the most probable hypothesis in our case, but an endemic form cannot be discarded *a priori*.

It was mentioned in the introduction of this paper that traces of reliable treponemal cases in osteoarchaeology are very rare. To our knowledge, following the reports by FERENCZ and JÓZSA (1990) and MARCSIK (1994), the presented case is the third reported paleopathologic case of treponematosis from Hungary, in spite of the thousands of skeletons examined previously. This underlines the importance of the publication of these data, for diagnostic and also paleoepidemiologic reasons.

The scarcity of the discoveries is more characteristic - and problematic - in more ancient historical periods. This lack of data (especially in the Old World) has generated much controversy regarding the origins of treponemal disease and, in particular, acquired syphilis (e. g. HUDSON, 1958; COCKBURN, 1961; HACKETT, 1963; GRMEK, 1983; BAKER and ARMELAGOS, 1988; LIVINGSTONE, 1991; ROTHSCHILD and ROTHSCHILD, 1996; BRUN, 1996).

Fortunately, recent discoveries in this field (e. g. STIRLAND, 1991; HENNEBERG and HENNEBERG, 1992; PÁLFI et al., 1992; BLONDIAUX and ALDUC-LE BAGOUSSE, 1994; ROBERTS, 1994; ROTHSCHILD et al., 1995; HADJOUIS, 1996), have, at least partially, resolved the problem. Ever more scientists accept that treponematosis (or treponematoses) was (were) present in both hemispheres before the discovery of America, and that we have to search for the ancestor of *Treponema pallidum* in the same area as one of the ancestors of the genus *Homo*: in Africa (e. g. DUTOUR et al., 1994; FROMENT, 1994; POWELL, 1994; ROTHSCHILD et al., 1995; BRUN, 1996). However, the interpretation of the origin of the venereal syphilis is still controversal (ANDRÉ, 1994; ROTHSCHILD et al., 1995; BRUN, 1996; DUTOUR et al., 1996; ROTHSCHILD and ROTHSCHILD, 1996).

Some questions are resolved, others are just appearing: the definitive scenario of the history of treponematoses is still a long way off. It seems absolutely certain, however, that human paleopathology and particularly paleoradiology, will contribute largely in future researches on this topic.

Acknowledgements

The autors are grateful to Dr. GY. SZÉKELY, archeologist of the Katona József Museum in Kecskemét, for his helpful collaboration and discussions about the archeological context of the cemetery; to Professor GY. FARKAS, head of the Department of Anthropology, József Attila University, for his permission to study of the skeletal material; and to Professor O. DUTOUR (Laboratoire d'Anthropologie Biologique, Université de la Méditerranée, Marseille), for his participation in the paleopathologic diagnosis.

This research was supported by grants of the "AMFK" (Hungary) and "MENESR" (France).

References

ANDRÉ, L. (1994): Le mal ramené du Nouveau Monde en 1493 était-il le Sida? In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe: avant ou aprés 1493? - Errance, Paris, 274-277.

BAHK, Y. W. (1994): Combined scintigraphic and radiographic diagnosis of bone and joint diseases. - Springer-Verlag, Berlin-Heidelberg.

BAKER, B. J. and ARMELAGOS, G. J. (1988): The origin and antiquity of syphilis: palaeopathological diagnosis and interpretation. - Current Anthropology *29*, 703-737

BLONDIAUX, J. and ALDUC-LE BAGOUSSE, A. (1994): Une tréponématose du Bas-Empire romain en Normandie? In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe: avant ou aprés 1493? - Errance, Paris, 99-100.

BRUN, J.-P. (1996): De la syphilisation à la civilisation : monde antique et tréponématoses. - Paper presented to the 1816e Réunion de la Société d'Anthropologie de Paris, 22-23 Novembre 1996, Marseille.

COCKBURN, T. A. (1961): The Origin of the Treponematoses. - Bulletin of WHO *24*, 221-28.

DUTOUR, O., PÁLFI, GY. and BRUN, J-P. (1996): Syphilis en Europe - elle y aurait présente dés l'Antiquité. - Pour la Science (Edition Française de Scientific Americain) *220*, 26-27.

DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J-P. (eds) (1994): The origin of syphilis in Europe. - Errance, Paris.

EDEIKEN, J., DALINKA, M. and KARASICK, D. (1990): Edeiken's roentgen diagnosis of diseases of bone. - Williams & Wilkins, Baltimore.

FERENCZ, M. and JÓZSA, L. (1990): Congenital syphilis on a Medieval skeleton. - Ann. Hist.-Nat. Mus. Nat. Hung. *82*, 227-33.

FROMENT, A (1994): Les tréponématoses: Une perspective historique. In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe: avant ou aprés 1493? - Errance, Paris, 260-268. pp.

GRIMPREL, E. (1993): Diagnostic des tréponématoses humaines par réaction de polymérisation en chaîne (PCR). - Annales de l'Institut Pasteur, actualités *4/4*, 306-308.

GRMEK, M. D. (1983): Les maladies à l'aube de la civilisation occidentale. - Payot, Paris.

HACKETT, C. J. (1963): On the origin of the human treponematosis. - Bulletin of WHO *29*, 7-41.

HACKETT, C. J. (1976): Diagnostic criteria of syphilis, yaws and treponarid and of some other diseases in dry bone. - Springer Verlag, Berlin.

HADJOUIS, D. (1996): Présence d'une probable tréponématose (syphilis congénitale précoce) sur un squelette de nouveau-né datant du premier âge de Fer (Thais, Val-de-Marne, France). - Paper presented to the 1816e Réunion de la Société d'Anthropologie de Paris, 22-23 Novembre 1996, Marseille.

HENNEBERG, M., HENNEBERG, R. and CARTER, J. C. (1992): Health in Colonial Metaponto (Health among the Ancient Greeks, Metaponto, Southern Italy, 600 to 250 BC). - National Geographic Research and Exploration *8*, 446-459

H. TÓTH, E. (1990): Négy évtized régészeti kutatásai Bács-Kiskun megyében (1949-1989). - Cumania *12*, 81-234.

HUDSON, E. H. (1958): The treponematoses - or treponematosis? - British Journal of Venereal Diseases *34*, 22-24.

KNUSSMANN, R. (1988): Anthropologie. - Gustav Fischer Verlag, Stuttgart. *1*, 421-479.

LAGIER, R., BAUD, C. A. and KRAMAR, C. (1994): Les bases anatomiques du diagnostic de syphilis osseuse en paléopathologie. In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe: avant ou aprés 1493? - Errance, Paris, 58-62 pp.

LIVINGSTONE, F. B. (1991): On the Origin of Syphilis: An Alternative Hypothesis. - Current Anthropology *32(5)*, 587-590.

MARCOVE, R. and ARLEN, M. (1992): Atlas of bone pathology. - J. B. Lippincott Company, Philadelphia.

MARCSIK, A. (1994): Data to the epidemiology of syphilis in ancient populations in Central Europe. In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe: avant ou aprés 1493? - Errance, Paris, 233-236 pp.

MARTIN, P. M. V. (1993): Le Pian: résurgence d'une tréponématose endémique. - Annales de l'Institut Pasteur actualités *4/4*, 303-305.

NABARRO, D. (1954): Congenital Syphilis. - Edward Arnold, London.

NOORDHOEK, G. T., WIELES, B., VAN DER SLUIS, J. J. and VAN EMBDEN, J. D. A. (1990) - Polymerase chain reaction and synthetic DNA probes: a means of distinguishing the causative agents of syphilis and yaws? - Infect. Immun. *58*, 2011-2013.

ORTNER, D. J. and PUTSCHAR, W. G. J. (1985): Identification of pathological conditions in human skeletal remains. - Smithsonian Institution Press, Washington.

PANUEL, M. (1994): Aspects radiographiques de l'atteinte squelettique de la syphilis congénitale. In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe : avant ou aprés 1493 ? - Errance, Paris, 36-40 pp.

PÁLFI, GY., DUTOUR, O., BORRÉANI, M., BRUN, J-P. and BÉRATO J. (1992): Pre-Columbian Congenital Syphilis from the Late Antiquity in France. - International Journal of Osteoarchaeology *2*, 245-261.

POWELL, M. L. (1994): Treponematosis before 1492 in southeastern United States of America: Why call it syphilis? In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe : avant ou aprés 1493? - Errance, Paris, 158-163 pp.

RESNICK, D. and NIWAYAMA, G. (1988): Diagnosis of Bone and Joint Disorders. - Saunders, Philadelphia.

ROBERTS, C. (1994): Treponematosis in Gloucester, England: a theoretical and practical approach to the pre-Columbian theory. In: DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (eds): L'origine de la syphilis en Europe: avant ou aprés 1493? - Errance, Paris, 101-108 pp.

ROTHSCHILD, B. M. and ROTHSCHILD, C. (1995): Treponemal disease revisited: skeletal discriminators for yaws, bejel, and veneral syphilis. - Clinical Infectious Diseases *20*, 1402-8.

ROTHSCHILD, B. M. and ROTHSCHILD, C. (1996): Treponemal disease in the New World. - Current Anthropology *37*, 555-561.

ROTHSCHILD, B. M., HERSKOVITZ I. and ROTHSCHILD, C. (1995): Origin of yaws in the Pleistocene. -Nature *378*, 343-344.

STEINBOCK, R. T. (1976): Paleopathological diagnosis and interpretation. - C. C. Thomas, Springfield.

STIRLAND, A. (1991): Pre-Columbian treponematosis in medieval Britain. - Int. J. Osteoarchaeol. *1*, 39-47.

VICENS, J. L., METGES, P. J. and DOURY, P. (1987): Tréponématoses - Encyclopédie Méd.-Chir., Appareil locomoteur, *14018* C 20,4. 12. 04. 5p. Paris.

ACTA BIOL. SZEGED. 42, pp. 123-133 (1997)

THE GREAT PLAGUE OF MARSEILLES (1720-1722): NEW ANTHROPOLOGICAL DATA

M. SIGNOLI[1], G. LEONETTI[2] and O. DUTOUR[1]

[1] *Laboratoire d'Anthropologie Biologique, Faculté de Médecine de Marseille - UMR 6578 CNRS/Université de la Méditerranée, 13385 Marseille Cedex 5, France;*

[2] *Service de Médecine Légale, Université de la Méditerranée, Faculté de Médecine, 27, Bd Jean Moulin, 13385 Marseille Cedex 5, France.*

(Received: December 27, 1996)

Abstract

The anthropological study of a mass grave dating from the great plague in Marseilles revealed new results concerning 18th century medical practice durin a severe epidemic.

Key words: apparent death, autopsy, biological anthropology, death verification, dissection, forensic anthropology, human osteoarchaeology, Marseilles, plague.

Introduction

The great plague of Marseilles accounted for about 50 000 victims in the alone town (CARRIERE et al., 1968). Corpses were buried in many graves scattered all over the town. Surprisingly, no anthropological studies have as yet been performed on these victims. A mass grave dating from this 18th century epidemic was recently discovered in the city centre, at the site of a planned housing development. A proposal for a complete anthropological study of this mass grave was submitted as part of our research proposal on the archaeology of human infections (DUTOUR et al., 1994a). The site was excavated in 1994. About 200 skeletons were taken out of this pit, which was dug at the time of the epidemic in the garden of the "Observance" monastery. A multidisciplinary (anthropological, paleopathological, historical and microbiological) study of this mass grave is in progress. The first results have provided the first evidence of the forensic practice used during this epidemic, observed in 2 neighbouring interments: verification of death by implantation of pins into the toes, and the first evidence of an autopsy performed during this epidemic, revealed by the opening of the skull of an immature skeleton.

Historical records

On the 25th of May 1720, the ship "Grand Saint-Antoine" returned from Syria to France, carrying the plague. The customary quarantine period was shortened, due to pressure from the town's financial community (BERTRAND, 1779), and this led to the introduction of the epidemic into Provence. The spread of this epidemic killed 100 000 persons in the region. In Marseilles, the number of deaths was about 50 000, corresponding to about half of the population. During the height of the epidemic, from June to August, the streets of the old city were covered with 7000 - 8000 corpses (BIRABEN, 1975). The epidemic lasted from June 1720 to August 1721. At the beginning of the spring of 1722, an epidemic relapse was observed. The number of reported victims of this second outbreak varies: 260 sick persons and 194 deaths according to MERY and GUINDON (1848); 174 victims according to CARRIERE et al. (1968); 700 people affected according to COLONNA D'ISTRIA (1968); but never as many as 1000. The city was again isolated. Some monasteries were again converted into hospitals, including the convent of the Augustines for the nobility, whilst common people were placed in the Charity. The convent of the Observantines was used as a hospital for quarantine. From the 18th to the 24th of May 1722 (CARRIERE et al., 1968; DUTOUR et al., 1994b), 50 peasants were recruited to dig a grave in the gardens of this convent, a pit large enough to accommodate 20 000 corpses. This mass grave was used from May to August 1722. It is the one we excavated in 1994.

Materials and methods

The excavation of the mass grave of the plague victims of the Observance hospital was performed in two steps (AFAN 210134062):

- The first step, in August 1994, was devoted to the collection of the bulk of the osteoarchaeological data (175 skeletons). Skeleton S 55 was collected in this first step, the anatomic practice was identified in the laboratory.

- The goal of the second step, from September to October 1994, in the central area of the pit, was to obtain additional data on the mode of interment of plague victims. Two of us (O. D. and M. S.) performed a planimetric excavation on a limited area and charted the precise positions of the skeletons found. This very careful technique, involving the same methodology as that applied to prehistoric digs, allowed us to observe the pins in place in the articular space of 2 of the 22 skeletons found in this area (SIGNOLI et al., 1996).

In the field, excavation was performed by the generally accepted method of field anthropology (DUDAY et al., 1990). Individual data on each skeleton were recorded and the precise orientation was charted on a general map. We analyzed the precise position of the skeleton in the field in order to determine the chronology of the burial, and used forensic methods to interpret the states of rigor mortis processes. In the laboratory, age and sex determinations were performed through use of a combination of different techniques from anthropology and forensic science (BRUZEK, 1992; BUIKSTRA et al., 1994; ISCAN, 1989). Reconstruction of the pin implantation process on a cadaver's toes was performed by using a similar needle. Reconstruction of the cranial autopsy was performed on an anatomical specimen, using an old bone-saw according to a medical treatise from the 18th century.

Historical research was carried out by one of us (M. S.) in the archives of the city in order to authenticate and date the mass grave, and in the old medical treatises of 17th and 18th centuries in order to document the different forensic and autopsy techniques used.

Results

S 155 and S 158: Our work revealed the presence of a bronze pin *in situ* in the of the two neighbouring skeletons (numbers S 155 and S 158, Fig. 1). In the case of S 155, the point of the pin touched the distal tip of the first phalanx, at the anterior and inner part of the articular area, at an angle of about 30° to the axis of the first phalanx, in the horizontal plane (Fig. 2). In the case of S 158, a Roman concrete block weighing around 40 kg was positioned on the distal skeleton of the lower leg. The floor of a roman *domus* was destroyed by the gravediggers in May 1722. After the removal of this block, we discovered, *in situ*, a twisted bronze pin in close contact with the phalanx of the right big toe (Fig. 3).

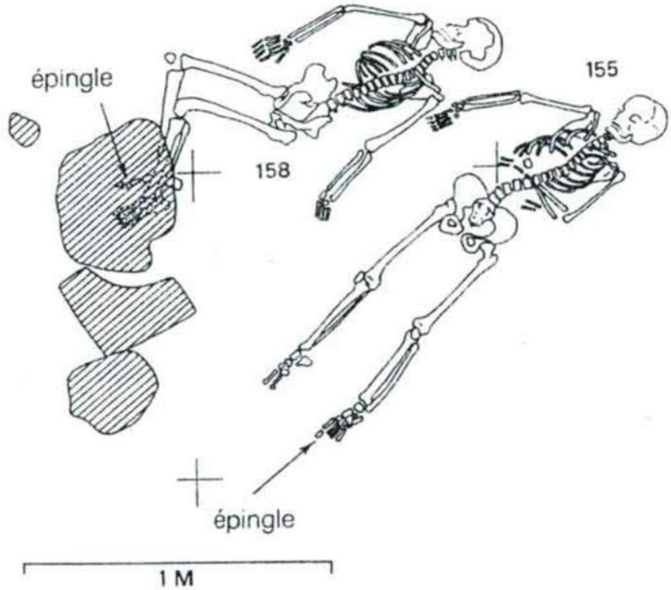

Fig. 1. A close view of the burial positions of skeletons S 155 and S 158 (drawing by J. DA SILVA and Y. ASSIÉ).

The presence of such pins associated with these two skeletons, clearly observed in the articular space, cannot be interpreted as fortuitous, or having occurred, for example, during the fixing of the shroud, but clearly indicates a deliberate act. The historical records revealed that, during this epidemic, the shroud was only sewn and not fixed by pins (BIRABEN, 1975). The positions of the skeletons did not reveal any *post mortem* changes; every part of the skeletons was perfectly in place.

S 55: In the central area of the pit, skeleton S 55 was that of an adolescent (about 15 years old), probably male and buried between two adults. The skull of the skeleton had been partially destroyed by the weight of the mechanical shovels, before the beginning of the excavation of this area, and the lack of the cranial vault was not noticed in the field. However, the horizontal section of the skull is clearly visible on the pictures taken in the field (Fig. 6).

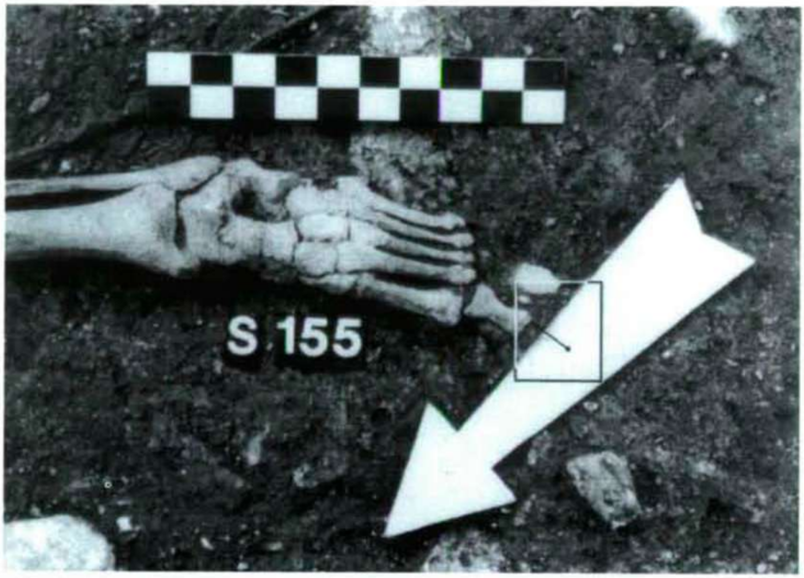

Fig. 2. S 155, showing the bronze pin in place, touching the distal tip of the first phalanx at the anterior and inner part of the articular area (photo by M. SIGNOLI).

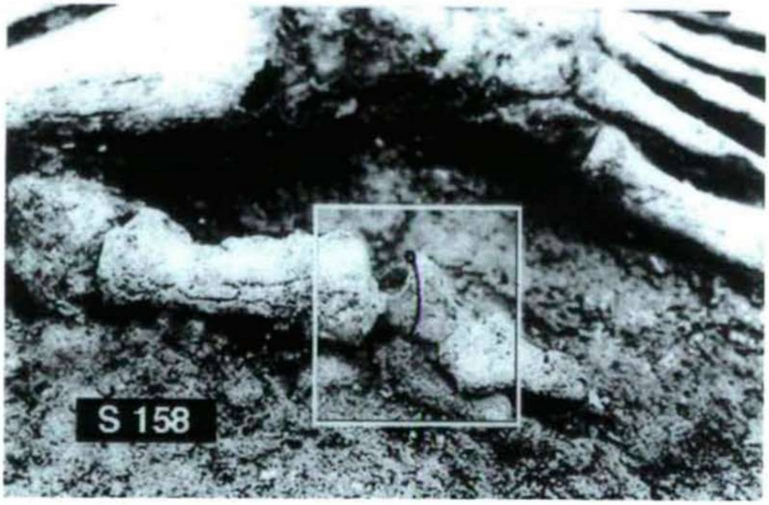

Fig. 3. A twisted bronze pin discovered in place in contact with the first phalanx of the right big toe of S 158 (photo by M. SIGNOLI).

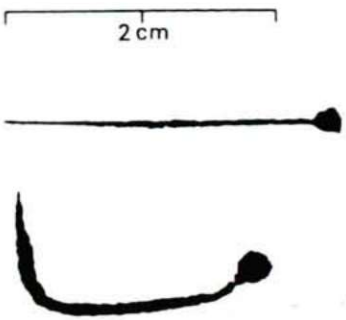

Fig. 4. The two bronze pins discovered in place in the toes of the neighbouring skeletons S 155 and S 158 (drawing by Y. ASSIÉ).

The reconstruction of the skull in the laboratory showed that the section is perfectly horizontal, starting from the supraglabellar area to the lambda, going just above the squamous part of the temporal bone (Figs 7 and 8). A small angulation of the section line is observed in the temporal area, and a tiny line, located just above this section line, is present in the frontal area and in the left lateral part of the skull. These data allow the conclusion that the section was performed with a bone-shaw after the preparation of a guideline. The regularity of the section line attests to the perfect technique of the surgeon (DUTOUR et al., 1995; DUTOUR et al., 1996).

Discussion

S 155 and S 158: The method of implantation of these pins was better understood after a reconstruction on an anatomical specimen, using needles of similar length and diameter (SIGNOLI et al., 1996). In the first case (S 155), the position and orientation of the pin observed in the field led us to believe that the pin had been introduced under the big toenail (LEONETTI et al., 1997). The reconstruction showed us that in this method, if the pin is almost completely driven under the nail, the extremity of the pin comes into contact with the distal part of the first phalanx, on the anterior part of the articular surface. The angle with the axis of the first phalanx in the horizontal plane is due to the hyperextension of the distal phalanx on the proximal one. In the second case (S 158), the mode of implantation is more complex: a very similar position was obtained by the introduction of the pin outside the *extensor hallucis,* in close contact with the bone of the phalanx, and it was then bent over the big toe (LEONETTI et al., 1997). By this method, we obtained the same curvature of the pin (Fig. 4).

The historical data at the end of the 17th and the 18th centuries revealed that in France there was a fear of "false death" and the burial of living people. This anxiety was based on a corpus of popular legends, and on the writings of classical authors. PLATO (the Laws, XII, 959) evoked the necessity of burying corpses only after 3 days of

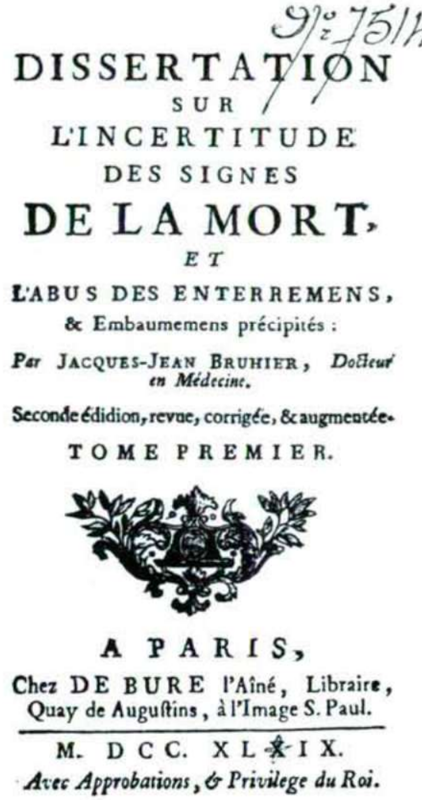
DISSERTATION
SUR
L'INCERTITUDE
DES SIGNES
DE LA MORT,
ET
L'ABUS DES ENTERREMENS,
& Embaumemens précipités :
Par JACQUES-JEAN BRUHIER, Docteur en Médecine.
Seconde édidion, revue, corrigée, & augmentée.
TOME PREMIER.
A PARIS,
Chez DE BURE l'Aîné, Libraire,
Quay de Auguſtins, à l'Image S. Paul.
M. DCC. XLIX.
Avec Approbations, & Privilege du Roi.

Fig. 5. Frontispiece of the medical treatise on forensic techniques by BRUHIER D'ABLAINCOURT (1749).

exposure, in order to differentiate a real death from a lethargy. PLINY (Hist. Nat., VII, 53) quoted a case of revival during cremation. This image was reinforced in the 16th century by descriptions of cases of false death, such as a premature dissection of a woman by the famous anatomist VESALIUS (PARE, 1573). In the second half of the 17th century and in the 18th century, testamentary writings revealed a great number of requests for a public and prolonged exhibition of cadavers in order to verify the reality of death (ARIES, 1977). At that time, physicians reported on cases of false death, sometimes followed by premature burial or dissection. During epidemics, and especially during the plague, the risk of burying still-living people was increased, due to the necessity of rapid burial in order to avoid contagion (ZACCHIAS, 1651; LANCISI, 1707; BRUHIER D'ABLAINCOURT, 1749). Certain sanitary rules prescribed that the funeral had to be carried out during the first 6 hours following death (BIRABEN, 1975). However, during the plague epidemic in Marseilles, the rules specified that the grave-diggers could not take any cadaver without the authorization of the person in charge of the hospital (PAPON, 1800). It is noteworthy that the plague epidemic provoked an indifference to the true state of cadavers (MILANESI, 1991). BRUHIER D'ABLAINCOURT (1749) (Fig. 5) reported the answer, made in the Provençal language, of a grave-digger who was putting a still-living man into his "tombereau" with cadavers: *"es proun mouert"*, that is to say: *"he has sufficiently died"*. This practice is also attested to by Roux: *"..les forçats qui entraient dans les maisons pour en sortir les morts pillaient de tous côtés et s'il sy trouvait un moribond, témoin de leurs larçins, ils avaient le secret de l'étouffer et de l'emporter dans leur chariot .. d'autres, ayant perdu tout sentiment d'humanité avaient la cruauté dy jeter des mourants lorsquils se trouvaient à portée"*.

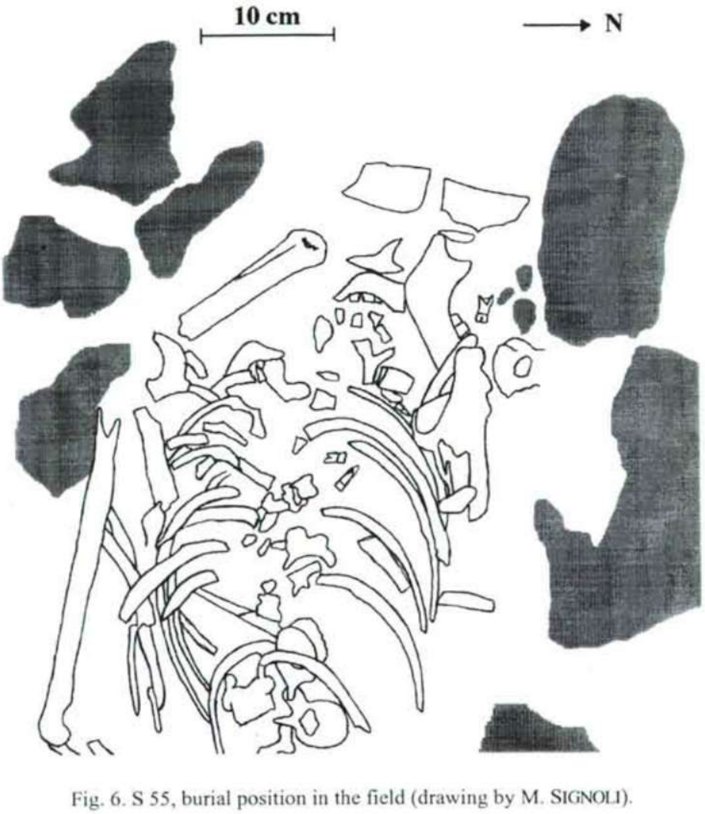

Fig. 6. S 55, burial position in the field (drawing by M. SIGNOLI).

To avoid these premature burials, many tests of verification were described by the physicians (ZACCHIAS, 1651). Among these techniques for verification of death, one notes the "surgical" methods, including cutting, burning or implantation of pins on the palmar surface of the hands, or the scapular area, or under the plantar surface of the feet, and the implantation of pins under the toe nails (*aciculam sub ungue digiti pedis*) (ZACCHIAS, 1651; BONET, 1679; LANCISI, 1707; WINSLOW, 1740; BUFFON, 1749). According to WINSLOW (1740), the reliability of these surgical techniques was as poor as that of the other methods in use. The conception shared by physicians since the 17th century was that, except for the first signs of putrefaction, nothing was truly reliable for the diagnosis of death: *ait, hominem vere mortuum non nisi incipiente putredine cadaveris certo cognosci posse* (ZACCHIAS, 1651).

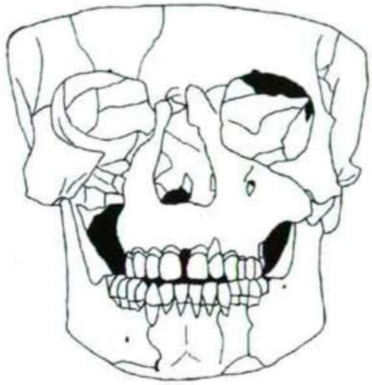

Fig. 7. S 55, anterior view of the skull (drawing by M. SIGNOLI).

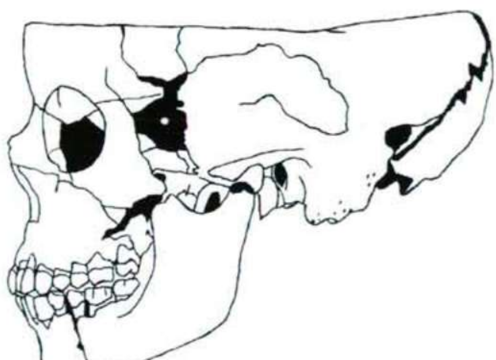

Fig. 8. S 55, left lateral view of the skull (drawing by M. SIGNOLI).

S 55: At the beginning of the 18th century, autopsy was a well-known and quite old medical practice. According to PROCOPE, in 542, during the plague epidemic in Constantinople, some physicians died rapidly after they performed autopsies (*Bellum Persicum*, II, 22). Several engravings testified to the opening of the corpses during the medieval period. Such dissections were performed during the 16th, 17th and 18th centuries, and followed very precises rules described in anatomic treatises (Fig. 9). Three parts of the body were regularly opened: the abdominal, thoracic and cranial cavities *"On apporta à l'Infirmerie le 17 janvier de cette année un homme de trente ans,* *qui mourut de la peste. Le bas-ventre étant ouvert, on vit l'épiploon parsemé de taches pourprées, la rate verdâtre... La poitrine étant ouverte, le poulmon se trouva fort gonflé, d'une couleur livide, rempli d'un sang noirâtre & écumeux... Le crâne étant ouvert, nous trouvîmes la dure mere enflammée à la partie de cette membrane qui est sous la fontaine, & le sinus longitudinal vuide & desséché..."* (Letter from Doctor CROUZIER, May 1722, in SÉNAC, 1744).

Fig. 9. Headline of A. VESALIUS (1539).

However, the skull was sometimes not opened, because it needed special tools (Fig. 10):*"Je l'ouvris le matin (le cadavre d'une femme morte dans la nuit de la peste), vers les huit heures, & je me contentai d'examiner la poitrine & le bas ventre, parce qu'alors, je manquais d'instruments pour scier le crâne, & que nous n'avions remarqué aucune lésion à la tete.."* (CHICOYNEAU et al., 1720).

The skull was opened according to the following protocol: incision of the scalp in two steps (sagittal and frontal), and opening of the skull with a bone-shaw after the drawing of a guideline (DEIDIER, 1742).

Conclusions

These two discoveries are the first anthropological evidence of medical practices during past epidemics, in this case the great plague in the first quarter of the 18th century. The medical treatises of the 17th century carefully described many forensic techniques to verify whether death was real and permanent, and in particular the implantation of pins into the toes. It should be noted that the main cause of apparent death is presented in the same medical treatises as the plague. The anatomical treatises and wood engravings since the 15th century attest to the practice of autopsies. This discovery is the first osteoarchaeological evidence of the performance of this practice during an epidemic of plague. This observation leads to the question of the notion of contagion of the plague. This notion was paradoxically commonly admitted by the sanitary system since the 15th century, but surprisingly disputed in the 17th century by some medical authorities, e.g. the physician of the Regent. This non-contagious theory allowed the performance of normal autopsies in this very dangerous context. This result underlines the efficiency of collaborative researches between biological anthropology, archaeological and forensic sciences in the understanding of medical behaviour and past epidemics.

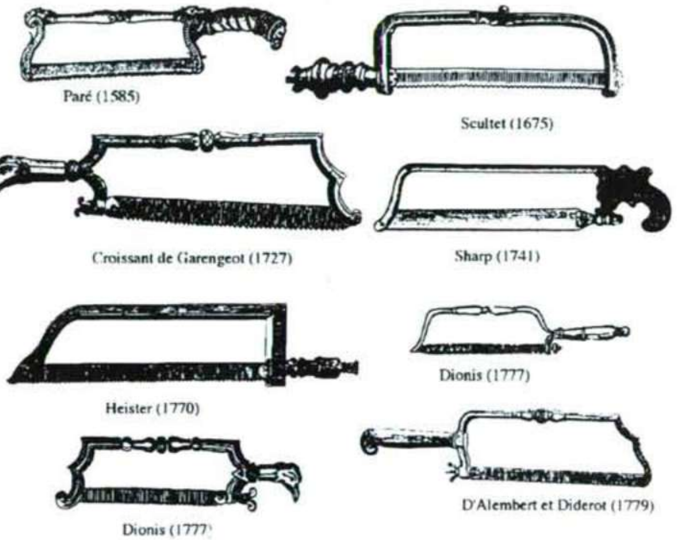

Fig. 10. Bone-shaws used during the 16th, 17th and 18th centuries.

References

ARIES, P. (1977): L'Homme devant la mort. - Seuil, Paris.
BERTRAND, J. B. (1779): Relation historique de la peste de Marseille en 1720. - Mossy, Amsterdam.
BIRABEN, J. N. (1975): Les hommes et la peste en France et dans les pays européens et mediterranéens. - EHESS, Centre de Recherches Historiques, Paris.
BONET, T. (1679): Sepulchretum sive Anatomia practica ex cadaveribus morbo donatis, proponens historias et observatione omnium pene humani corporis affectum. - Cramer et Perachon, Genève.

BRUHIER D'ABLAINCOURT, J. J. (1749): Dissertation sur l'incertitude des signes de la mort et l'abus des enterrements et embaubements preciptes. - De Bure, Paris.
BRUZEK, J. (1992): Diagnose sexuelle à partir du squelette : possibilités et limites.- Archeo-Nil, 43-51.
BUFFON, G. L. (1749): Histoire naturelle de l'homme. - Paris.
BUIKSTRA, J. E. and UBELAKER, D. H. (1994): Standards for data collection from human skeletal remains. - Arkansas Archeological Survey, Fayetteville, Arkansas.
CARRIERE, C., COURDURIE, M. and REBUFFAT, F. (1968): Marseille, ville morte: la peste de 1720. - Garçon, Marseille.
CHICOYNEAU, F., VERNY, J. and SOULLIER, J. (1720): Relation succincte touchant les accidents de la peste de Marseille, son prognostic et sa curation. - Bruyset, Lyon.
COLONNA D'ISTRIA, M. (1968): Etude épidemiologique de la peste de 1720 à Marseille. - Thèse de la Faculté de Médecine et de Pharmacie de Marseille, Marseille.
DEIDIER, A. (1742): Traité d'anatomie raisonnée du corps humain où l'on donne la manière de le dissequer - Houry, Paris.
DUDAY, H., COURTAUD, P., CRUBÉZY, E., SELLIER, P. and TILLIER, A. M. (1990): L'anthropologie de terrain: reconnaissance et interpretation des gestes funeraires. - Bulletins et Memoires de la Societé d'Anthropologie de Paris II *3-4*, 29-50.
DUTOUR, O., PÁLFI, GY., BÉRATO, J. and BRUN, J. P. (1994): L'origine de la syphilis en Europe: avant ou apres 1493 ?. - Errance - CAV, Paris.
DUTOUR, O., SIGNOLI, M., GEORGEON, E. and DA SILVA, J. (1994b): Le charnier de la Grande Peste de Marseille (1720-1722) de la rue Leca: données de la fouille de la partie centrale et premiers résultats anthropologiques. - Préhistoire et Anthropologie Méditerranéennes *3*, 191-203.
DUTOUR, O. and SIGNOLI, M. (1995): L'anthropologue de 1995 à la recherche de l'anatomiste marseillais de 1720: mise en evidence anthropologique d'un geste de dissection pendant la Grande Peste de Marseille (Fosse des Jardins de l'Observance). - 77ème Congrès de l'Association des Anatomistes de Langue Française, Marseille, Resumes: 133.
DUTOUR, O., SIGNOLI, M., BOETSCH, G., BRUNET, C., LEONETTI, G. and CHAMPSAUR, P. (1996): Les jardins de l'Observance : Marseille 1722. - Réalisation : Vidéo In Production, 10'.
ISCAN, M. Y. (1989): Age markers in the human skeleton. - Thomas, Springfield.
LANSICI, G. M. (1707): De subitaneis mortibus. - Roma.
LEONETTI, G., SIGNOLI, M., PELISSIER, A-L., CHAMPSAUR, P., HERSHKOVITZ, I., BRUNET, C. and DUTOUR, O. (1997): Verification of death: evidence of pins implantation during the Great plague of Marseilles (1722) - J. Forensic Sci. (in press).
MERY, L. and GUINDON, F. (1848): Histoire analytique et chronologique des actes et des déliberations du Corps et du Conseil de la municipalité de Marseille, depuis le Xe siècle jusqu'à nos jours. - Marseille.
MILANESI, C. (1991): Mort apparente, mort imparfaite : Médecine et mentalités au XVIIIe siècle. - Payot, Paris.
PAPON, J. P. (1800): De la peste ou les époques mémorables de ce fléau et les moyens de s'en préserver. - Lavilette, Paris.
PARE, A. (1573): Deux livres de chirurgie. - Paris.
PLATO (PLATON): Les Lois. In: Oeuvres complètes. Translation by A. Dies and E. des Places. - Les Belles Lettres, Paris, 1951-1975.
PLINY (PLINE L'ANCIEN): Histoires Naturelles. Translation by E. LITTRE. - Paris, 1848.
PROCOPE: Corpus Scriptorum Byzantinae.
ROUX, P.H.: Relation succincte de ce qui s'est passé à Marseille pendant la peste de 1720 et de 1722, de son principe, des effets qu'elle a produits, de ses suites et de sa fin; suivi des précautions à prendre pour s'en préserver. - Marseille.
SENAC, J-B. (1744): Traité des causes, des accidents, et de la cure de la peste avec un recueil d'observations, et un détail circonstancie des précautions qu'on a prises pour subvenir aux besoins des peuples affligés de cette maladie, ou pour la prévenir dans les lieux qui en sont menacés. - Paris.
SIGNOLI, M., DA SILVA, J., GEORGEON, E., LEONETTI, G. and DUTOUR, O. (1996): Vérification de la mort durant la Grande Peste de Marseille: données anthropologiques issues de la fouille du charnier de l'Observance. - Comptes Rendus de l'Académie des Sciences de Paris *322*, 333-339.
WINSLOW, J. B. (1740): Quaestio medico-chirurgica... An mortis incertae signa minus incerta a chirurgicis, quam ab aliis experimentis? In: Disputationis in Academia Medicinae Parisiensi discussae quae collepsit, selegit, ordinarit. - Paris.
ZACCHIAS, P. (1651): Quaestiones medico-legales. - Amsterdam.

ACTA BIOL. SZEGED. 42, pp. 135-143 (1997)

INTERPRETATION OF 10TH-11TH CENTURY POPULATIONS IN THE NORTHERN PART OF THE REGION EAST OF THE TISZA ON THE BASIS OF REPRESENTATIVE SAMPLES

L. SZATHMÁRY[1], ZS. GUBA[1], S. OLÁH[2] and I. PAP[3]

[1]*Department of Human Biology, Kossuth Lajos University, Debrecen, H-4010 P.O.B. 6, Hungary;*
[2]*Department of Anthropology, József Attila University, Szeged, H-6701 P.O.B. 660, Hungary;*
[3]*Department of Anthropology, Hungarian Natural History Museum, Budapest, H-1062, Bajza utca 39.*

(Received: December 20, 1996)

Abstract

An attempt was made to interpret the break in the population history of North-Eastern Hungary at the turn of the 10th and 11th centuries (the time of conversion to Christianity) through estimation of the diversity of three representative chronopopulations. This change in population history is indicated by data on representative cemeteries (Ibrány-Esbó Halom, Sárrétudvari-Hízóföld, Szabolcs-Petőfi utca) and interpopulation and intrapopulation aspects. The diversity of the 11th century population surpasses that of the 10th century population (independently of their geographic locations).

Key words: Ancient Hungarians, 10th-11th centuries, craniological diversity.

Introduction

The only previous way to reconstruct the 10th-11th century population history of the North-Eastern part of the Carpathian Basin was on the basis of cemeteries that were only partly known (ÉRY, 1978, 1994; SZATHMÁRY 1996, and in press). Recent findings indicate that a very significant change occurred in the North-Eastern region at the beginning of the 11th century, as concerns the structure of the population; the extent of this change can be compared only to the genetic impulse induced by the conquering Hungarians (SZATHMÁRY, 1996, in press; SZŰCS et al., 1997).

The aim of this paper is to attempt to interpret this change in population history within the transitional period between the Pagan period and the Early Christian period on the basis of skull finds from three representative cemeteries.

Material and method

The chronological distribution of adult skeleton finds from the cemeteries studied is favourable since we could monitor both intrapopulation and interpopulation relations during the 10th and 11th centuries. Our database was as follows:

Group 1 = IbE10 / Ibrány-Esbó halom (10th century part): 16 males and 16 females (ISTVÁNOVITS, 1996a, 1996b; SZATHMÁRY et al., 1996) (Tables 5 and 6)

Group 2 = SaH 10 / Sárrétudvari-Hízóföld (10th century): 51 males and 36 females (NEPPER, 1996; OLÁH, 1990, 1991) (Tables 7 and 8)

Group 3 = IbE11 / Ibrány-Esbó halom (11th century part): 23 males and 22 females (ISTVÁNOVITS, 1996a, 1996b; SZATHMÁRY et al., 1996) (Tables 5 and 6)

Group 4 = SzP11 Szabolcs-Petőfi utca (11th century part); 22 males and 12 females (KOVÁCS, 1994; PAP, 1980-81) (Tables 9 and 10).

The 11 analysed dimensions on the restored skulls had the following Martin nos. (MARTIN, 1928): 1, 5, 8, 9, 17, 20, 48, 51, 52, 54 and 55. The missing values (maximum 8 for individuals, maximum 30% for variables) were reconstructed by the DEAR (1959) method. The calculated data comprised 19% of the whole database. The reconstruction of the different values for these two centuries was based on the full database of the North-Eastern region. This relates to 139 males and 91 females in the 10th century (cf. SZŰCS et al., 1997) and to 83 males and 54 females in the 11th century (cf. SZATHMÁRY et al., 1996). The investigations on the total ranges of data were made by discriminant (dsc) analysis.

Results

Of the three dsc functions, the first two were significant in both sexes (Tables 1 and 2). Therefore, it is worth surveying the positions of the centroids in the first two dimensions (Fig. 1).

The result clearly demonstrates that the population at Ibrány-Esbó halom was not homogeneous. Its 10th century population was nearly as far from the 10th century sample at Sárrétudvari (geographically distant from it) as from its own 11th century population. Previous findings (SZATHMÁRY et al., 1996; SZŰCS et al., 1997) suggested that the population at Ibrány from the Age of the Hungarian Conquest had completely changed by the 11th century. At present, we are still unable to define the ethnic group which followed the 10th century one. We only suspect that the influence of the population movements which affected the North-Eastern region at the end of the 10th century and at the beginning of the 11th century did not extend to Transdanubia (SZŰCS et al., 1997). The extreme position of the 11th century population at Szabolcs-Petőfi utca for both sexes is worthy of mention. Thus, the two 11th century samples have significantly different anatomical characters. These significant differences may be due to the populations in the Early Arpadian having different roots and it is most probable that they cannot be derived from local origins.

Table 1. Canonical discriminant functions - Males.

Fcn	Eigenvalue	Pct of variance	Cum pct	Canonical correlation	After Fcn	WILKS' lambda	Chi-square	df	Sig
					0	0.2920	127.41	33	0.0000
1*	0.8665	52.88	52.88	0.6814	1	0.5450	62.82	20	0.0000
2*	0.6796	41.48	94.36	0.6361	2	0.9154	9.15	9	0.4239
3*	0.0924	5.64	100.00	0.2908					

* Denotes the 3 canonical discriminant functions remaining in the analysis.

Table 2. Canonical discriminant functions - Females.

Fcn	Eigenvalue	Pct of variance	Cum pct	Canonical correlation	After Fcn	WILKS' lambda	Chi-square	df	Sig
					0	0.2970	94.07	33	0.0000
1*	1.1482	69.47	69.47	0.7311	1	0.6382	34.81	20	0.0211
2*	0.2878	17.41	86.88	0.4728	2	0.8218	15.21	9	0.0854
3*	0.2168	13.12	100.00	0.4221					

* Denotes the 3 canonical discriminant functions remaining in the analysis.

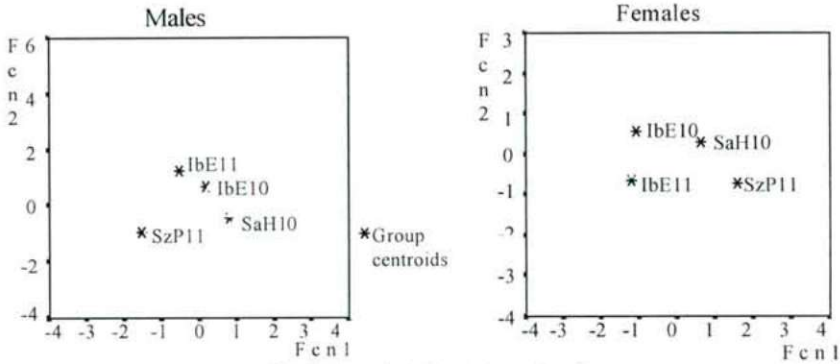

Fig. 1. Canonical discriminant functions

The classification results (Tables 3 and 4) yield the surprising result that the 10th century population at Ibrány was heterogeneous in both sexes, as presumed previously for the Upper Tisza region on the basis of fragmentary samples (SZATHMÁRY, 1996; SZATHMÁRY et al., 1996). At the same time, in the 11th century in the North-Eastern region, the characteristics of an unbalanced population dynamics of mosaic character can be reconstructed. For example, the females from Ibrány are more heterogeneous than the males, while in Szabolcs the opposite trend may be observed.

Table 3. Classification results - Males.

Actual group	No. of cases	Predicted group membership as a percentage 1	2	3	4
1 Ibrány-Esbó halom 10th century	16	50.0	18.8	18.8	12.5
2 Sárrétudvari-Hízóföld 10th century	51	13.7	74.5	3.9	7.8
3 Ibrány-Esbó halom 11th century	23	17.4	8.7	73.9	0.0
4 Szabolcs-Petőfi utca 11th century	22	9.1	0.0	13.6	77.3

Percentage of "grouped" cases correctly classified: 71.4%

Table 4. Classification results - Females.

Actual group	No. of cases	Predicted group membership as a percentage 1	2	3	4
1 Ibrány-Esbó halom 10th century	16	56.3	25.0	12.5	6.3
2 Sárrétudvari-Hízóföld 10th century	36	2.8	83.8	2.8	11.1
3 Ibrány-Esbó halom 11th century	22	27.3	0.0	68.2	4.5
4 Szabolcs-Petőfi utca 11th century	12	8.3	0.0	0.0	91.7

Percentage of "grouped" cases correctly classified: 75.6%

When only the Ibrány sample is investigated by dsc analysis, in the 10th century population 94% of the males, and in the 11th century population 83% of the males are characteristic of their own periods. The survivor population accounts for 12% among males and 24% among females.

Conclusions

Certain craniological arguments may corroborate the earlier hypothesis that the 10th century population characteristic of the Age of the Hungarian Conquest in NE Hungary might have changed significantly by the 11th century.

Table 5. Ibrány-Esbó halom - Basic data on adult males.

Grave	Measurements (MARTIN, 1928)													
no.	M1	M5	M8	M9	M17	M20	M45	M48	M51	M52	M54	M55	M66	Century
154	191		128	91		117		71	39	35	25	52	81	10
164	181		147	91		112			32	31	19		103	10
170	175			99		114		68	39	34	28	49		10
176	183	101	156	114	129	114		70	41	36	21	50		10
189	186		138	96		112		64			24	47		10
190			152	109	144	119					27		102	10
203	184		145	103		119							91	10
215	189	106	152	102	133		129	66	40	32	25	52	105	10
236	184	109	146	97	132	105		74	43	36	26	55	100	10
249	185		126	94	114			66	37	34	27	50	99	10
250	190		131	96		104			44					10
256	194		128	91		111	123	73	43	34	24	54	86	10
258	195		134	94		121			42	37	27			10
260	183	111	142	97	136	110		73	40	30	28	51	110	10
262	185	106	138	93	132	113			36	26	24	48	104	10
267						121			39		26	49		10
14	187		134	95		106		72	35	31	22	52		11
17	179	115	156	105	141			76	43	34	25	47		11
29	182	97	144	95	124	105	121	69	40	32	23	53	89	11
37	193	101	144	96	130	119		68	43	30		55		11
39	162		164	101		116			43	34	24			11
44	164		150	93		111	131	68	38	32	23	48	102	11
53	175	96	152	101	141	122	139	73	40	32	22	53	96	11
64	189	105	140	109	132	117		68	38	29	26	49		11
69	189	111	147	110	148	120					24		94	11
71	192	101	144	100	131	108					28		97	11
75	195	103	148	102	133	111			36	34	27			11
81	187	96	143	101	130	106	137	72	40	33	23	51		11
90	196		137	97		118					28			11
93	172	98	140	91	126	111		68	38	31	24	49	99	11
94			141		147	124			40	33			100	11
101	190		138	94		116		73	40	38	26	56	110	11
107	183	98	140	100	122	106					28		102	11
111	184	98	135	97	133	110	126	65	32	38	26	46	98	11
112	187		142	99		127			40	31				11
119	194		134	97		118		71	37	34	26	49		11
130	178		132	92		113		68	39	31	28	46		11
135	180		155	94		118		70	39	29	28	51		11
136	182		127	90		102		68	39	32	22	53		11

Table 6. Ibrány-Esbó halom -Basic data on adult females.

Grave	Measurements (MARTIN, 1928)													
no.	M1	M5	M8	M9	M17	M20	M45	M48	M51	M52	M54	M55	M66	Century
11	176		132	95		102			32	28	25			10
152	188		144	98		110			40	36			82	10
168						111		69	39	31	28	51	107	10
169	179		132	94		102	120	61	38	32	27	46	83	10
178	181		139	96		99		65	39		18	45	83	10
184	171		156	104		110			36	29				10
195	181	112		90	139	119								10
220	151		164	86		103		67	33	35	24	51	97	10
230	190		126	98		112					20		88	10
234			147	91					36	29	21		89	10
235			131			109			38	33			91	10
237	181		138	96		106		63	37	32		51		10
239	177		131	91		106			36		20		94	10
251			142	102					45				95	10
252	185		138	97		113			40	28	20		95	10
253	171	93	137	87	128	104	114	67	38	33	22	49		10
10	167		156	89		113		66	39	32	24	50		11
20	184		126	91		109			39					11
23	181	101	132	94	142	107	112	69	41	32	25	47		11
31	191		136	92		114		69	38	36	22	51	94	11
32	179		117			96					18		85	11
38	168	88	134	92	123	98	111	65	36	34	23	47		11
40	157		148	97		113		66	39	32	24	46		11
54	177	103	139	99	127	110			38	37	18	51	91	11
58	171	96	141	96	128	101	126	56	37	32	24	42	98	11
59	181	98	140	95	138	112		66	37	31	28	45		11
62	186	106	140	98	134	108		71			26	52	92	11
78	170	96	144	100	136	118			38	34	25			11
79	178	88	148	100	129	116			34		24		91	11
85	179	98	132	95	125	100			36	30			80	11
89	181		129	97		112		65	39	37	24	47	100	11
92	174	100	133	92	117	95		62	36			44	92	11
99	184		139	102		108			37	32	26			11
100	174		134	93		111								11
108	176	95	136	98	130	108		60	39	33	29	45	83	11
117	159	86	141		118	106								11
125	167		131			111							98	11
132	177		151	95		100								11

Table 7. Sárrétudvari - Hizóföld - Basic data on adult males.

Grave	Measurements (MARTIN, 1928)													
no.	M1	M5	M8	M9	M17	M20	M45	M48	M51	M52	M54	M55	M66	Century
3	179	100	149	93	142	118	145		41	35	23		107	10
9	184		125			109							91	10
11	169			96				67	39	31	23	52		10
14	186	100	142	96	137					36	23			10
20			138	94		118					26		104	10
21				99				78	45	35	27		94	10
29				98				76		36		57	102	10
34	173	95	158	96	133	122	138	63	40	28	23	47	95	10
37	181	110		102	132	122		65	43	33	27	49	93	10
41				102				67	42	35	25			10
45			128	92		115							93	10
48				100						31	26		104	10
51	186	109	142	99	148	120		61	44	33	25	51	102	10
51	186	109	142	99	148	120		61	44	33	25	51	102	10
62		101		96	137	114		76				52	101	10
72				91				69			24	52	94	10
80	204		155	101		127		66	42	31		51	100	10
90	187		131	95		116		72	42	36	24	59		10
100	179	104	141	101	134	110							110	10
105	179	104	140	96	137	111					27		113	10
106				102				63		32	27	51	101	10
108	165	95	151	105	134	114	136	67	41	31	26	52	103	10
112	178		156	101		116	156	72	44	33	29	57		10
123	207		140	98				72	45	33		58		10
124	195	112	145	104	142	120	133	69	43	31	26	56		10
128				103				67			24	52		10
145			130	92	129	110							87	10
146	176	103	157	105	142	123	144	67	41	32	26	52	102	10
149	190		138	94		112		68	44	33		52	110	10
160	184	99	144	91	126	110		65			24	49	100	10
169	187	104	136	104	138	110	131	71	41	31	30	55	105	10
171			153	100		120	142	73	42		28	55	104	10
179	190	110	139	87	137	114							108	10
181	196	97	139	99	132	116		72	43	37	23	54	100	10
182	186	100	139	99	135	117		68	41	32		49		10
183	197	111	140	104	141	119	137	67	46	35	29	50	114	10
185	194			89		120			40				106	10
186	193	98	151	101	137	123	136	70	41	33	24	53		10
188	184		147			116	134				25		110	10
201	188		144	95		116		68			24	53	107	10
202	175	99	141	102	131	116		63	41	32	30		94	10
214	181		137	94	141	117		69	40	32	24	55	94	10
218	190		145					65			25	55		10
228	191		134	99		117					24		100	10
231	169		146	102		112		65	45	32	27	52	106	10
232	183	100	143	103	137	113		75	44	39			105	10
237	184		145	101		113							103	10
242			145			120		63					96	10
243			152	102		116		62			22	45		10
244	183			94		107							94	10
245	190		149	107	137	117								10
247	180	99		99	128	111	134	65			27	51	102	10
252	184			96		116		68	44	37	25	54	102	10
257			147	98		116							101	10
258				108		118		73	44	35	28	55	95	10
259	182	105	141	98	134	114	135	67	43	35	26	54	103	10

Table 8. Sárrétudvari - Hizóföld - Basic data on adult females.

Grave	Measurements (MARTIN, 1928)													
no.	M1	M5	M8	M9	M17	M20	M45	M48	M51	M52	M54	M55	M66	Century
10	193		130			105							88	10
12	174	100									26		96	10
13	185	105	134		137	115								10
19	164	93	147	95	129	111	129	65	40	35	24	50		10
22	179			94		112			42	34			104	10
23	185	97	137	87	121	102							93	10
28	174	98	138	90	128	103	119	63	41	31	23		97	10
32				87				63		34		42		10
43	184	98	135	97	130	109					25		99	10
53	181		138	94		107		70	43	35			92	10
97				94				69	42	38	25	54		10
99	171	102	145		133	117								10
101	187	107	132	93	136			63	40	36		51	99	10
107				97				76	45	35	26	55	91	10
118		89		98	127			66	40	34		52	95	10
119			132	98	130	105							92	10
131	174	88	138	96	128	112							101	10
134				93		107	126	62	38	30	24	47	98	10
148	179		132	96		115							88	10
151	185		140	94		113	125	70	41	34	27	54		10
159				92	135	112							100	10
167	177	104		98	143	119		64	42	32		48	93	10
177	181	95	135		130	110							90	10
189	173	93	148	94	132	109	129	63	46	35		46	101	10
191			135	97					42	32			103	10
192	176			92							24		92	10
194	178	99	142	99	136	120		65	41		24	48	99	10
204	177	96	143	93	127	107							95	10
205	193	107	131	101	131	112	126	64	43	36		48	97	10
207	168			93		114		63	41	35	26	47		10
208			140	96				66				49		10
225	165	92	144	93	127	107		60	40	35	23	46	87	10
229	189		139	100		115							91	10
233				92		110		63	43	31	24	49		10
239	184		134	103		114							97	10
240	180			99		116							82	10
249	177		139	95		107							88	10
256	186		138	98									94	10
261	186		136	95	135	113	128	66				49	94	10
263	186	104	144	106	125	108								10
265	187	101	135	92	138	121		64	43	32	23	51	99	10
268	187		141	101		113			41	32				10

Table 9. Szabolcs - Petőfi utca - Basic data on adult males.

Grave	Measurements (MARTIN, 1928)													
no.	M1	M5	M8	M9	M17	M20	M45	M48	M51	M52	M54	M55	M66	Century
74	168		130	98									105	11
90	181	103	137		140	113	135	74	44	30	26	52	110	11
91	182	103	145	96	127	113	139		44	38	24	53	97	11
93	170	98	148	92	132	117	140	73	45	33	26	54	97	11
95	187	109	140	96	146	119					19			11
116	184	106	133	97	133	108	134	72	45	32	24	48	103	11
140	185	100	140	96	125	111	124	70	42	32	26	49	105	11
141	185	100		94	132			63	45	33	24	46		11
151	189	100	134	102	131	114	128	68	43	32	26	51	96	11
158	198	108	139	99	138									11
164	171	95	146	97	131	113		74	44	33	20	54	91	11
191	184			99				76	48	34	31	52		11
198	103	108	137	95	136	113	133	68	43	32	23	50		11
280								70	42	31	23	50		11
285	190		131	92		117								11
300	193		139	96				72	45	32	28	52		11
320	186	105	137	95	138	112					26			11
330				91				64	42	34	24	48		11
337	178		140	96		113								11
343	180		150	98		117		75	43	32	26	54	116	11
349	176	99	141	97	131	113	135	67	43	31	24	49		11
352	178	90	141	94	131	114		68	45	32	24	52		11

Table 10. Szabolcs - Petőfi utca - Basic data on adult females

Grave	Measurements (MARTIN, 1928)													
no.	M1	M5	M8	M9	M17	M20	M45	M48	M51	M52	M54	M55	M66	Century
104	175		136	91		109		69	44	33			96	11
134	185	98	141	95	129	112		64	45	33	27	47		11
147	181	100	136	94	127	108		58	42	31	24	46		11
155	182	98	134	92	128			71	42	32	24	51		11
178	170		135	89			127	66	41	32	24	51	92	11
195		92		85	116			58	40	32	24	42		11
213			137	95				67	42	31	27	50		11
262			142	94	134	113							99	11
298	172	99	134	91	128	108	125	71	42	35	22	49	97	11
334				91				68	42	33				11
354	183	98	135	100	129	113		60	41	30	30	48		11
362				91				63	41	31	24	49		11

References

DEAR, E. A. (1959): Principal Component Missing Data Method for Multiple Regression Models. SD Corp. - Technical Report SP-86.

ÉRY, K. (1978): Regionális különbségek a magyarság X. századi embertani anyagában. - Anthrop. Közl. *22*, 77-86.

ÉRY, K. (1994): A Kárpát-medence embertani képe a honfoglalás korában. In: KOVÁCS, L. (ed.): Honfoglalás és régészet. - Balassi Kiadó, Budapest, 217-224 pp.

ISTVÁNOVITS, E. (1996a): 10-11. századi temető Ibrány Esbó halmon. In: A magyar honfoglalás korának régészeti emlékei. - Hermann Ottó Múzeum, Miskolc, 25-46 pp.

ISTVÁNOVITS, E. (1996b): Ibrány-Esbóhalom. In: FODOR, I. (ed.): A honfoglaló magyarság. - Kiállítási katalógus, Magyar Nemzeti Múzeum, Budapest, 145-150 pp, 6th map.

KOVÁCS, L. (1994): Das früharpadenzeitliche Gräberfeld von Szabolcs. - Varia Archeologica Hungarica, VI, Budapest.

MARTIN, R. (1928): Lehrbuch der Anthropologie. - Fisher, Jena, 2. Aufl. 2. Bd.

NEPPER, I. (1996): Sárrétudvari-Hízóföld. In: FODOR, I. (ed.): A honfoglaló magyarság. - Kiállítási katalógus, Magyar Nemzeti Múzeum, Budapest, 257-281 pp, 13th map.

OLÁH, S. (1990): Sárrétudvari-Hízóföld honfoglalás kori temetőjének történeti embertani értékelése. - Univ. Doct. Diss., JATE, Szeged, (manuscript).

OLÁH, S. (1991): Egy 10. századi minta paleodemográfiai vizsgálata. - MFMÉ, Szeged, 641-650 pp.

PAP, I. (1980-81): Anthropological investigation of the Árpadian Age population of Szabolcs-Petőfi utca. - Anthrop. Hung. XVII, 65-107 pp.

SZATHMÁRY, L. (1996): Honfoglalás kori népességünk struktúrája. In: PÁLFI, Gy. et al. (eds) Honfoglaló magyarság. - Árpád-kori magyarság, JATE Embertani Tanszék, Szeged, 87-96 pp.

SZATHMÁRY, L. (in press): Magyarország 10. századi népességének diverzitása. - JAMÉ, Nyíregyháza.

SZATHMÁRY, L., GUBA, Zs. and ISTVÁNOVITS, E. (1996): Az Ibrány-Esbó halmi 10-11. századi temető népessége. In: ERDÉLYI, I. (ed.): Panyola - Településtörténeti kutatási eredmények. - Károli Gáspár Ref. Egyetem, Budapest, 73-85 pp.

SZŰCS, L., GUBA, ZS., SZATHMÁRY, L. and ALMÁSI, L. (1997): 10th century (Age of the Hungarian Conquest) craniological analogies of the 10th-11th century population of the Ibrány-Esbó halom cemetery. - Acta Biol. Szeged. *42*, (in press).

ACTA BIOL. SZEGED. 42, pp. 145-150 (1997)

ANTHROPOLOGICAL INVESTIGATION OF THE 18TH-19TH CENTURY OSSUARY OF THE DOMINICAN CHURCH AT VÁC, HUNGARY

Preliminary report

I. SZIKOSSY[1], ZS. BERNERT[2] and I. PAP[1]

[1]*Department of Anthropology, Hungarian Natural History Museum, H-1062 Budapest, Bajza u. 39.;*
[2]*Department of Biology, Kodolányi János Institute, Budapest, Hungary*

(Received: January 17, 1997)

Abstract

During reconstruction work, in 1994-95 265 naturally mummified individuals and an ossuary with the remains of approximately 40 individuals were uncovered in the crypts of the Dominican Church at Vác, Hungary. The specimens had been buried continuously during the period 1731-1838. The anthropological material of the ossuary was examined, the number of secondarily buried specimens was identified and the age and sex distributions of the remains were considered.

Key words:18th-19th century, Dominican Church at Vác, naturally mummified bodies, ossuary.

Introduction

During reconstruction work in 1994-95, 265 naturally mummified individuals and an ossuary with the remains of approximately 40 individuals were uncovered in the crypts of the Dominican Church at Vác, Hungary. The excavation was led by the ethnographers MÁRTA ZOMBORKA (Tragor Ignác Museum, Vác) and EMIL RÁDULY (Open Air Museum, Szentendre). ÉVA SUSA, a forensic anthropologist (Forensic Institute, Budapest), regularly participated as an anthropologist in the process (ZOMBORKA, 1966).

The bones belonging to given individuals could have been sorted by appropriate, level by level excavation (UBELAKER, 1989). However, during the exposure, the ossuary was excavated vertically from the one end of the box to the other. Additionally, the anthropologist was not present. Since time was short, the contents of the ossuary were rapidly put into boxes. When the boxes arrived at the Department of Anthropology, the remains had to be replaced again.

The anthropological remains are currently stored at the Department of Anthropology, Hungarian Natural History Museum.

In the present study, the anthropological material of the ossuary was examined in order to identify the number of individuals, and to establish the age and sex distributions of the remains.

Material and method

The ossuary was found at the end of a small corridor of the crypt. This corridor had been closed off by a cavity containing an ossuary. The cavity was more or less closed, and was surrounded by Medieval wall remains. The size and shape of the cavity were quite unusual: 5.2 m long by 1 m wide at one end, but only 80 cm wide at the other. The ossuary was a large wooden box precisely tailored into this cavity. The painted wooden box contained the remains of 40 individuals. During the second inhumation, the more or less decomposed remains of the dead were collected and reburied in the ossuary, since the crypt had been filled up.

The registers of deaths kept at the rectory and the painted texts on the coffins gave the exact date of death of the mummified individuals found in the crypt. According to these, the burials of the individuals may be dated to 1731-1841.

Unfortunately, such exact data are not available in the case of the ossuary. Most probably it contains the bone material of the coffins exhumed at the end of the 18th century (ZOMBORKA, 1996).

The ossuary contained bones, partially mummified human remains, pieces of dried-out soft tissues, hair remains, and textile remains and scrapings in a large quantity. Locally, grub remains were found among the remains. The position photographs revealed that the human remains were not always placed into the box in anatomical order. Corpses in different states of preservation and decomposition must have been put on top of one another.

Colourful fungi and bacteria plaque were observed on the bones and soft tissues of the mummies and the contents of the ossuary. Samples were taken from the plaque for microbiological examinations. As the first step of preservation, the remains were exposed to X-radiation to disinfect them (3 minutes, 4.5 mA, 75 kV/90 kV).

In examinations of the anthropological material in the ossuary, the method described in the manual by UBELAKER (1989) was applied. Use was also made of the methods of ÉRY and SUSA (1994), applied during the analysis of a 20th century mass grave (Budapest, Soroksár Street), and the publication of BARTUCZ (1966) concerning the skeletons in the Kiskunhalas ("Kurucz-hill") mass grave.

The anthropological examination procedure was started by a classification of the bones. After sorting, the left and right femora were identified, and the pelvises were pieced together.

Estimations of the morphological sex and age had to be made for each bone separately, since the bones were disarticulated.

In estimations of sex, 12 anatomical characters were considered on the skull and 9 on the pelvis (ÉRY et al., 1963; ACSÁDI and NEMESKÉRI, 1970; ÉRY, 1992). Estimations of biological age involved examinations of the numbers and developmental stages of deciduous and permanent teeth (SCHOUR and MASSLER, 1941; UBELAKER, 1989), and the lengths of the long bones (STLOUKAL and HANÁKOVÁ, 1978) in the Infans I and II age groups. Since mummification was advanced, the method of tooth eruption could not be applied in some cases, and accordingly the standards for head circumference given in the publication of EIBEN et al. (1992) were applied.

The surface changes in the facies symphyseos of the ossis pubis were scored for the age groups adultus, maturus and senilis (SUCHEY, 1979; KATZ and SUCHEY, 1986; BROOKS and SUCHEY, 1990). The stages of ectocranial suture closure were scored (Meindl and Lovejoy, 1985) when the soft tissues allowed this.

The examinations also extended to the stages of demineralization of the roots of the permanent teeth (LAMENDIN et al., 1992) and the abrasion of the permanent teeth (BROTHWELL, 1972).

Results

Microbiological results

The microbiological examinations did not demonstrate any microorganisms which implied danger to the researchers or the remains. Only the presence of *Clostridium* sp., aerosporatic bacteria, and ordinary mildew was found.

Characteristics of bone material

The excavation of a secondary burial is a complex task. The locations and the relationships of the bones may provide a picture of the inhumation procedure. When a small number of individuals are involved, the best method is to record the position of each bone exactly, using detailed descriptions, measurements and photographs. Of course, it is difficult to apply this method to a large number of specimens. The extent of the secondary burial is an important factor, since the material should be removed as rapidly as feasible after exposure, in order to avoid damage (UBELAKER, 1989). As mentioned above, the time available for the exposure was very short, and this determined the procedures applied during the discovery. It should be stressed that the rapidness of exposure is not to be confused with the rapidity of the post-exposure procedures. Under favourable circumstances, by means of professional methods, it

Table 1. Frequency of disarticulated bones of adults in the ossuary, Dominician Church at Vác.

Sort of Bones	Number of Bones		Minimum No. of Individuals
Cranium	11		11
Calvarium	5		5
Mandibula (separated)	6		6
Atlas	18		18
Axis	17		17
Corpus sterni	25		25
Vertebra cervicalis	78		16
Vertebra dorsalis	276		23
Vertebra lumbalis	135		27
Os sacrum	30		30
(Pelvis)	31		31
	Right	Left	
Clavicula	18	23	23
Scapula	26	26	26
Humerus	24	24	24
Radius	22	21	22
Ulna	24	22	24
Os coxae	28	28	28
Femur	25	28	28
Patella	8	11	11
Tibia	26	26	26
Fibula	28	26	28
Calcaneus	20	24	24

would have been possible to identify the bones belonging to the given individuals and to accumulate much more information.

The bones were brownish, and in many cases dark-brown as a result of organic material. The bone texture was decomposed, its density was decreased, and its texture had become fragile.

Table 2. Age and sex distribution based on the skulls.

Age groups	Male	Female	Undeterminable Sex	Total
Perinatal	-	-	2	2
Infans I	-	-	8	8
Infans II	-	-	-	-
Juvenile	-	-	-	-
Adultus	2	1	-	3
Maturus	6	5	-	11
Senium	1	1	-	2
Total	9	7	10	26

Table 3. Age distribution based on the pelvis of adults (SUCHEY and BROOKS method).

No.	Sex	Phase	Age
1.	female	V	40-65
2.	male	VI	49-73
3.	male	V	35-56
4.	female	III	23-39
5.	female	V	34-63
6.	female	V	34-63
7.	male	III	22-35
8.	female	V	34-63
9.	female	V	34-63
10.	male	IV	26-45
11.	female	III	23-39
12.	female	V	34-63
13.	male	II	20-27
14.	male	IV	26-45
15.	male	IV	26-45
16.	female	VI	48-72
17.	male	V	35-56
18.	male	IV	26-45
19.	female	IV	27-49
20.	male	IV	26-45
21.	male	IV	26-45
22.	male	IV	26-45
23.	female	IV	27-49
24.	female	III	23-39
25.	female	-	?
26.	female	III	23-39
27.	female	III	17-22
28.	female	-	?
29.	female	II	20-30
30.	female	I	17-22
31.	male	-	?

Ten percent of the bones of individuals buried secondarily in the ossuary were lacking post mortem. In almost all cases, mummified remains of soft tissues could be observed on the surfaces of the bones. Dried soft tissue was found in the skull. Dark hair remains were sometimes present.

The mummification process was more advanced for the skulls of children.

Number of individuals; distributions according to sex and age

From the separate examination of the different sorts of bones, it was estimated that the remains of at least 31 adults and 15 subadults were buried in the ossuary. The frequencies of disarticulated bones in the ossuary are shown in Table 1. The maximum number of individuals was indicated by the number of pelvises. The minimum number of individuals, 22, was indicated by the skull remains. Besides 16 skulls, 6 separate mandibles were also found.

As concerns the 10 children (2 of perinatal age, 8 of Infans I age), postcranial skeletons were found in addition to skulls (Table 2). Five subadults (3 of Infans I, and 2 of Infans II age) yielded only postcranial skeletons.

The skulls suggested the following sex distribution: 9 males and 7 females. Two-thirds of them belonged to the mature age group. Examinations of the pelvises indicated 13 males and 18 females. The ages estimated by the SUCHEY-BROOKS method are given in Table 3, together with the sex distribution.

Acknowledgements

Thanks are due to Professor LÁSZLÓ JÓZSA (National Traumatological Institute, Budapest) for the microbiological examinations on the tissue samples, and to Dr. BRUNO KAUFMANN (Anthropologisches Forschungsinstitut, Aesh BL) for the microbiological examinations and the performance of the processes of disinfection and preservation.

The study was performed with the support of National Scientific Research Foundation (OTKA grants No. T 020323 and F 020133).

References

ACSÁDI, Gy. and NEMESKÉRI, J. (1970): History of Human Life Span and Mortality. - Akadémiai Kiadó, Budapest.

BARTUCZ, L. (1966): A praehistorikus trepanáció és orvostörténeti vonatkozású sírleletek. Palaeopathologia III. - Az Országos Orvostörténeti Könyvtár Kiadványa, Budapest

BROOKS, S. and SUCHEY, J. (1990): Skeletal Age Determination Based on the Os Pubis: a Comparison of the ACSÁDI-NEMESKÉRI and SUCHEY-BROOKS Methods. - Human Evol. *5(3)*, 227-238.

BROTHWELL, D. R. (1972): Digging Up Bones. - British Museum of Natural History, London.

EIBEN, O. G., FARKAS, M., KÖRMENDY, I., PAKSY, A., VARGA TEGHZE-GERBER, ZS. and VARGHA, P. (1992): A budapesti longitudinális növekedésvizsgálat 1970-1988 (The Budapest Longitudinal Growth Study 1970-1988). - Humanbiol. Budapest. *23*, 5-208.

ÉRY, K. (1992): Útmutató a csontvázleletek feldolgozásához. - ELTE Embertani Tanszék, posztgraduális szakképzés jegyzete (kézirat), Budapest.

ÉRY, K., KRALOVÁNSZKY, A. and NEMESKÉRI, J. (1963): Történeti népességek rekonstrukciójának reprezentációja. - Anthrop. Közl., *7*, 41-90.

ÉRY, K. and SUSA, É. (1994): A Budapest Soroksári úti XX. századi tömegsír embertani vizsgálata - Anthrop. Közl., *36*, 319.

KATZ, D. and SUCHEY, J. (1986): Age determination of the male os pubis. - Am. J. Phys. Anthrop. *69*, 427-435.

LAMENDIN, H., BACCINO, E., HUMBERT, J. F., TAVERNIER, J. C., NOSSINTCHOUK, R. M., and ZERILLI, A. (1992): A simple technique for age estimation in adult corpses: the two criteria dental method. - J. Forensic Sc. *37(5)*, 1373-1379.

MEINDL, R. S. and LOVEJOY, C. O. (1985): Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateralanterior sutures. - Am. J. Phys. Anthrop. *68*, 57-66.

SCHOUR, J. and MASSLER, M. (1941): The development of the human dentition. - J. Amer. Dent. Assoc. *28*, 1153-1160.

STLOUKAL, M. and HANÁKOVÁ, H. (1978): Die Länge der Längsknochen altslawischer Bevölkerungen unter besonderer Berücksichtigung von Washstumsfragen. - Homo *29*, 53-69.

SUCHEY, J. (1979): Problems in aging of females using the os pubis. - Am. J. Phys. Anthrop. *51*, 467-470.

SUSA, É., PAP, I. and JÓZSA, L. (1996): A váci múmiák antropológiai vizsgálata (Mummies from the 18-19th century, Hungary). - Magyar Múzeumok *2(1)*, 14-16.

UBELAKER, D. H. (1989): Human skeletal remains, excavation, analysis, interpretation. - Taraxacum, Washington.

ZOMBORKA, M. (1996): Vác, "Fehérek temploma" kriptafeltárás 1994-95 (The exposure of the Dominic Crypt in Vác, the initial stages of the restoration). - Magyar Múzeumok *2(1)*, 3-7.

ACTA BIOL. SZEGED. 42, pp. 151-156 (1997)

10TH CENTURY (AGE OF THE HUNGARIAN CONQUEST) CRANIOLOGICAL ANALOGIES OF THE 10TH-11TH CENTURY POPULATION OF THE IBRÁNY-ESBÓ HALOM CEMETERY

L. SZŰCS, ZS. GUBA, L. SZATHMÁRY and L. ALMÁSI

Department of Human Biology, L. Kossuth University, H-4010 Debrecen, P.O.B. 6, Hungary

(Received: December 20, 1996)

Abstract

A search for 10th century regional craniological analogies of the 10th century population (16 males, 16 females) and the 11th century population (23 males, 22 females) of the Ibrány-Esbó Halom cemetery demonstrated that these populations had no significant local associations in the north-eastern region of the Carpathian Basin. While analogies of the 10th century population are to be found rather in the south-eastern region, those of the 11th century population can be identified rather in the Middle Danube region. It cannot be accidental that the greatest similarity can be demonstrated between the populations of these two regions in the 10th century (SZATHMÁRY, in press). It is noteworthy that the 10th century craniological analogies of the 11th-12th century population of Hajdúdorog-Temetőhegy, too, are to be identified rather in the south-eastern region than in its own (north-eastern) region (SZŰCS et al., 1996). All these analogies may suggest that the genetic roots of the presumed population alteration in the eastern part of the Carpathian Basin in about A.D. 1000 may originate from the gene pool of the Great Hungarian Plain and its periphery areas, i. e. the process was not connected with the population history events of Transdanubia.

Key words: Pagan and early Christian epoch, Carpathian Basin, craniology

Introduction

Between 1985 and 1990, ESZTER ISTVÁNOVITS excavated an undisturbed 10th-11th century cemetery of considerable extent (270 graves) at Ibrány (Upper Tisza region). On the basis of its clear inner chronology, this cemetery seemed to be suitable for a definitive interpretation of differences between the Pagan period population and the Early Christian period population (ISTVÁNOVITS 1996a, 1996b). Preliminary craniological investigations suggested that the Pagan period (Age of the Hungarian Conquest) and Early Christian period (11th century) populations differed from each other significantly, i. e. their genetic antecedents were shared to only a small degree, even Late Avar period anatomical parallels of the Upper Tisza region being detected in a virtually negligible percentage and only within the 10th century population. Thus, a break in the continuity of population history appeared at about the beginning of the reign of ISTVÁN I (AD 1000). The earlier population was followed by a population with an alien anatomical character, while the settlement history remained continuous

(SZATHMÁRY et al., 1996). This phenomenon can most probably be regarded as a general one for the Upper Tisza region (SZATHMÁRY, 1996).

In the present paper, an attempt has been made to estimate the frequency of craniological analogies of the 10th-11th century cemetery at Ibrány-Esbó Halom in five different regions in the central area of the Carpathian Basin.

Material and method

At Ibrány, the number of adult finds from the 10th century part of the cemetery was 16 males and 16 females, and from the 11th century part 23 males and 22 females (SZATHMÁRY et al., 1997).

As previously, the 10th century comparative material was composed of the finds of five geographic regions (SZŰCS et al., 1996). The principles of this process are summarized in the works of SZATHMÁRY (1996 and in press). This database was completed with the material of four additional sites. The 51 male and 36 female finds from Sárrétudvari-Hízóföld (OLÁH, 1990; NEPPER, 1996), the 3 male finds and 1 female find from the 10th century part of the 10 Szabolcs-Petőfi Street cemetery (PAP, 1980-81; KOVÁCS, 1994), the 3 male finds from the Tiszavasvári-Nagy Gyepáros cemetery (SZATHMÁRY and GUBA, 1996; NÉMET, 1996), and the new finds from Karos-Eperjesvölgy* (KUSTÁR, 1996; RÉVÉSZ, 1996) might significantly alter earlier knowledge on the 10th century population of the north-eastern region (cf. SZATHMÁRY, 1996).

The samples used for our analysis are summarized in Table 1.

Table 1. Material examined.

Samples	Males	Females
Ibrány-Esbó Halom (10th c.)	16	16
Ibrány-Esbó Halom (11th c.)	23	22
Comparative material (10th c.)		
1/ North-eastern region	123	75
2/ South-eastern region	26	18
3/ Northern periphery	34	27
4/ Middle Danube region	25	22
5/ Transdanubia	40	37

12 dimensions were analysed on the restored skulls, with the following MARTIN nos.: 1, 5, 8, 9, 17, 20, 45, 48, 51, 52, 54, and 55 (MARTIN, 1928).

The missing values (a maximum of 8 for the individuals; a maximum of 30 per cent for the variables) were reconstructed on the basis of the whole sample by using DEAR's method (1959). Following this, the investigation was made by discriminant (dsc) analysis.

Results

The results are presented on the basis of the results of dsc analysis classification. Average similarities were estimated for two different variants of reclassification (Tables 2 and 3), i. e. the Ibrány samples were interpreted from two different aspects. One was the degree of similarity between them and regional samples, while the other was what percentage of individuals from regional samples could be classified into the Ibrány

* The dimensions of the cranial finds of the first Karos cemetery, reported by LIPTÁK (1951), with the exceptions of the MARTIN dimensions 5 and 20 were re-determined by KUSTÁR. As a result, the comparative material was increased with the data on 17 males and 14 females.

Table 2. Reclassification rates (rounded data) of the 10th century population of Ibrány-Esbó Halom on the basis of the results of dsc analysis classification (in percentage).

Region		From the analysed sample		Into the analysed sample		Average re-classification
	males	6		11		
North-eastern region			3		10	7
	females	0		9		
	males	13		23		
South-eastern region			13		20	16
	females	13		17		
	males	19		9		
Northern periphery			16		5	10
	females	13		0		
	males	6		12		
Middle Danube region			6		15	11
	females	6		18		
	males	0		10		
Transdanubia			0		9	5
	females	0		8		

Table 3. Reclassification rates (rounded data) of the 11th century population of Ibrány-Esbó Halom on the basis of the results of dsc analysis classification (in percentage).

Region		From the analysed sample		Into the analysed sample		Average re-classification
	males	13		4		
North-eastern region			8		6	7
	females	0		8		
	males	13		15		
South-eastern region			16		13	15
	females	18		11		
	males	7		11		
Northern periphery			16		11	13
	females	14		14		
	males	9		24		
Middle Danube region			11		21	16
	females	14		18		
	males	17		5		
Transdanubia			9		8	8
	females	0		1		

samples. In fact, the average values of these reclassifications formed the basis of our opinion, that the 10th century population of Ibrány-Esbó Halom had the greatest similarity towards the craniological character of the south-eastern region (Fig. 1). At the same time, the 11th century population, with an anatomical character different from the previous one, is analogous primarily with the 10th century sample from the Middle Danube region (Fig. 2).

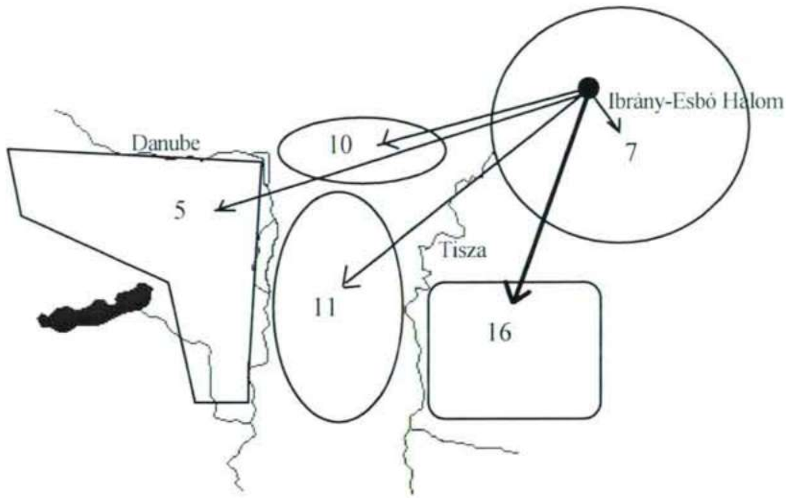

Fig. 1. Average results of reclassification of the 10th century population of the Ibrány-Esbó Halom cemetery.

Conclusions

A 10th-11th century population from the Upper Tisza region, with a presumed continuous settlement history, was divided from a craniological viewpoint into two parts. The population from the Pagan period and that from the Early Christian period were considered to differ significantly. The analogies of the 10th century population can be identified primarily in the south-eastern region of the Carpathian Basin, while the 10th century (Hungarian Conquest period) parallels of the 11th century population are the most explicit in the Middle Danube region. In the 10th century, these two regional groups were those between which the closest association could be demonstrated (SZATHMÁRY, in press). It is noteworthy that the 10th century analogies of the 11th-12th century population of Hajdúdorog-Temetőhegy (North-Eastern Hungary) can be identified not so much in the north-eastern region as in the south-eastern region (SZŰCS et al., 1996). The chronologically differing analogies of the 10th and 11th century populations of the Ibrány cemetery may indicate that the genetic roots of the population change in the eastern part of the Carpathian Basin at around the turn of the first and second millennia (approximately from the beginning of the reign of

István I) can be traced back rather to the Great Hungarian Plain and its periphery areas, and that they are not connected with the population history events with quite different character in Transdanubia.

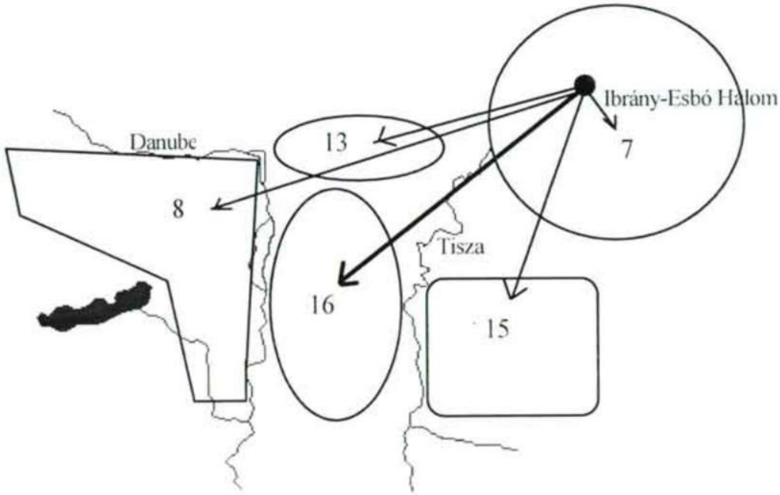

Fig. 2. Average results of reclassification of the 11th century population of the Ibrány-Esbó Halom cemetery.

References

DEAR, E. A. (1959): Principal component missing data method for multiple regression models. - SD Corp. Technical Report SP-86.

ISTVÁNOVITS, E. (1996a): 10-11. századi temető Ibrány Esbó halmon. - A magyar honfoglalás korának régészeti emlékei. Hermann Ottó Múzeum, Miskolc, 25-46 pp.

ISTVÁNOVITS, E. (1996b): Ibrány-Esbóhalom. In: FODOR, I. (ed.): A honfoglaló magyarság. - Kiállítási katalógus, Magyar Nemzeti Múzeum, Budapest, 145-150 pp, 6th map.

KOVÁCS, L. (1994): Das früharpadenzeitliche Gräbefeld von Szabolcs. - Varia Archeologica Hungarica *6*, Budapest.

KUSTÁR, Á. (1996): A Karos-Eperjesszögi I.-II.-III. számú honfoglalás kori temetők taxonómiai vizsgálata. - A magyar honfoglalás korának régészeti emlékei. Hermann Ottó Múzeum, Miskolc, 313-333 pp.

LIPTÁK, P. (1951): Anthropologische Beitrage zum Problem der Altungarns. - Acta Arch. Hung. *1*, 231-249.

MARTIN, R. (1928): Lehrbuch der Anthropologie. - Fisher, Jena, 2 Aufl. 2. Bd.

NEPPER, I. (1996): Sárrétudvari-Hízóföld. In: FODOR, I. (ed.): A honfoglaló magyarság. - Kiállítási Katalógus, Magyar Nemzeti Múzeum, Budapest, 257-281 pp, 13th map.

OLÁH, S. (1990): Sárrétudvari-Hízóföld honfoglalás kori temetőjének történeti embertani értékelése. - Univ. Doct. Diss., JATE, Szeged, (manuscript).

PAP, I. (1981): Anthropological investigation of the Arpadian Age population of Szabolcs-Petőfi utca. - Anthrop. Hung. *17*, 65-107.

RÉVÉSZ, L. (1996): Karos-Eperjesszög I-II temető. In: FODOR, I. (ed.): A honfoglaló magyarság. - Kiállítási Katalógus, Magyar Nemzeti Múzeum, Budapest. 82-109 pp, 1th and 2nd map.

SZATHMÁRY, L. (1996): Honfoglalás kori népességünk struktúrája. In: PÁLFI, Gy. et al. (eds): Honfoglaló magyarság Árpád-kori magyarság. - JATE Embertani Tanszéke, Szeged, 87-96 pp.

SZATHMÁRY, L. (in press): Magyarország 10. századi népességének diverzitása. - JAMÉ, Nyíregyháza.

SZATHMÁRY, L., GUBA, Zs. and ISTVÁNOVITS, E. (1996): Az Ibrány-Esbó halmi 10-11. századi temető népessége. In: ERDÉLYI, I. (ed.): Panyola - Településtörténeti kutatási eredmények. - Károli Gáspár Ref. Egyetem, Budapest, 73-85 pp.

SZATHMÁRY, L., GUBA, ZS., OLÁH and PAP, I. (1997 Interpretation of 10th-11th century populations in the Northern part of the region East of the Tisza on the basis of representative samples. - Acta Biol. Szeged. *42*, 00-00.

SZATHMÁRY, L. and GUBA, ZS. (1996): Tiszavasvári- Nagy Gyepáros honfoglalás kori (10. századi) temetőjének humán csontvázlelete. - A magyar honfoglalás korának régészeti emlékei. Hermann Ottó Múzeum, Miskolc, 22-24 pp.

SZŰCS, L., SZATHMÁRY, L., NYILAS, K. and GUBA, ZS. (1996): Hajdúdorog-Temetőhegy Árpád-kori népességének becsült honfoglalás kori (10. századi) előzményei. In: PÁLFI, GY. (ed.): Honfoglaló magyarság, Árpád-kori magyarság. - JATE Embertani Tanszéke, Szeged, 137-191 pp.

ACTA BIOL. SZEGED. 42, pp. 157-162 (1997)

A CONTRIBUTION TO THE QUESTION OF THE BIOLOGICAL CONTINUITY OF THE PREHISTORIC POPULATIONS IN THE EASTERN PARTS OF THE CARPATHIAN BASIN
(Penrose analysis of anthropological series from cemeteries of the Maros-Perjámos culture)

ZS. K. ZOFFMANN

Hungarian National Museum, H-1088 Budapest, Múzeum krt. 14-16, Hungary

(Received: December 17, 1996)

Abstract

A large number of Early and Middle Bronze Age anthropological series from cemeteries of the Maros-Perjámos Culture were compared with available series from the Neolithic period, and from the Copper, Bronze and Iron Ages in the Carpathian Basin. The results in part demonstrate the biological continuity of the autochton population, and also point to the existence of alien elements in this culture. For purposes of analysis, the significance limit was set at 0.5%.

Key words: Penrose analysis, Carpathian Basin, Neolithic, Copper, Bronze and Iron Ages.

Introduction

Anthropological knowledge of the archaeologically well-researched Bronze Age in the Carpathian Basin is rather fragmentary, mainly because of the lack of material (ZOFFMANN, 1994). Merely to mention only the most important general works, Farkas used taxonomy to examine the origins of different populations, whereas Szathmáry approached the problem through statistics (FARKAS, 1975; NEMESKÉRI and SZATHMÁRY, 1987; SZATHMÁRY, 1987). The investigation has now been extended to more recent materials in an attempt to shed light on the biological interrelations between the given populations by using the Penrose analysis, comparing the 10 most important measurements of the skull. The present analysis is based upon the Maros-Perjámos Culture of the Early and Middle Bronze Age, for wich cemeteries with high numbers of graves and published anthropological material are avaible (Csanytelek, Mokrin and Szőreg-C). Additional fragmentary series with compacted data were used from the cemeteries at Battonya, Deszk-A and Deszk-F. In the case of the Szőreg-C cemetery, it was possible to analyse series separately from the different consecutive periods. A comprehensive series (called the Maros series) has also been developed from the series listed, and was included in the analysis, serving as control series. Thus, a total of 8 series from the Maros-Perjámos Culture were compared with 5 series from the Neolithic period, 2 series from the Copper Age, 3 from the Bronze Age and 5 from the Iron Age. These series are listed in Table 1. Where possible, both the male and female series were compared independently as well (Tables 2 and 3). For purposes of the analysis, the significance limit was set at 0.5%.

Results

1. The Neolithic series was shown by an earlier analysis to constitute an isolated block among series of other Neolithic populations (ZOFFMANN, 1992), and again (except for Hrtkovci-Gomolava) it displayed no significant links to the Maros-Perjámos Culture. On the other hand the Hrtkovci-Gomolava series of the Vinča-Pločnik phase, though from a notably earlier period, similarly to the indication of the series from the Bodrogkeresztúr and Baden Cultures, shows that, this culture, with its surviving autochthon population, might have contributed to the formation of the Maros Culture as its territorial predecessor.

2. The two Copper Age populations lack any significant mutual links (ZOFFMANN, 1992). On the other hand, their numerous connections towards the Bronze Age series indicate the local Copper Age origin of the populations participating in the genesis of the Maros Culture.

3. The Hurbanovo and Ottomány series representing the early Bronze Age do not exhibit significant similarities with the Maros Culture. However, the Maros-Perjámos series themselves are connected to each other with strong significance in many cases. The only exceptions are the series of Csanytelek and Szőreg-C3. In the former case, this phenomenon can be explained in part by the fact that the population using the cemetery belonged to several different archaeological cultures, and in part by the presence of the unique brachicrany (SZALAI, 1995). In the latter case, the explanation might be sought in the archaeologically separate third period of the Szőreg-C cemetery, dating from the late middle Bronze Age (ŞANDOR-CHICIDEAN and CHICIDEAN, 1989). The Tápé series of the Late Bronze Age Tumulus Culture demonstrates significant similarities in three cases, again indicating the continuity of the populations following one another in time and space.

4. From among the available Iron Age series the Gomolava series shows significant links to the series of the Maros Culture. This series dates from that phase of the Bosut Culture when the ethnic groups coming from the East (from the territory that is now Romania) had not yet reached the Syrmia, i. e. the vicinity of Gomolava. Thus, an ethnic continuity between the Bronze and Iron Ages in these parts is readily presumable. Series from the Mezőcsát Culture and the Scythian Age give no Penrose links. However, there are significant links in the cases of the two Late Iron Age Celtic series; the Transdanubian Celts especially exhibit many links to the Bronze Age populations of the southern part of the Great Plain, despite their chronological and

Table 1. Penrose distances of the Maros-Perjámos series (males and females).

	Maros Culture	Battonya +Deszk-A +Deszk-F	Csany-telek	Mokrin	Szőreg C	Szőreg C1	Szőreg C2	Szőreg C3
1./ NEOLITHIC PERIOD								
Lengyel Culture: Aszód' 83 (ZOFFMANN, manuscript)	0.393	0.700	1.031	0.400	0.385	0.399	0.464	1.095
Lengyel Culture: Mórágy-B.1 (ZOFFMANN, manuscript)	0.380	0.737	1.024	0.352	0.384	0.418	0.530	0.969
South-Transdanubian Lengyel Culture (ZOFFMANN, 1984)	0.250	0.526	0.774	0.175	0.284	0.331	0.377	0.671
Tisza Culture (Zoffmann, 1992)	0.245	0.455	1.078	0.275	0.230	0.202	0.277	0.973
Vinča-Pločnik Culture: Hrtkovci-Gomolava (ZOFFMANN, 1984)	0.270	0.587	1.117	0.129	0.317	0.233	0.454	0.794
2./ COPPER AGE								
Bodrogkeresztúr Culture (ZOFFMANN, 1992)	0.134	0.302	1.235	0.196	0.134	0.124	0.171	0.702
Baden+Kostolac+Coțofeni Cultures (ZOFFMANN, 1992)	0.113	0.227	0.761	0.174	0.164	0.351	0.277	0.240
3./ BRONZE AGE								
Hurbanovo Culture: Bajč-Ragona (HANAKOVÁ et al., 1973)	0.185	0.219	0.762	0.218	0.273	0.393	0.464	0.387
Ottományi Culture (ZOFFMANN, manuscript)	0.558	0.363	0.792	0.772	0.570	0.989	0.691	0.383
Maroş Culture: Battonya+Deszk-A+Deszk-F (ZOFFMANN, manuscript)	-	-						
Maros Culture: Csanytelek (SZALAI, 1995)	-	0.814	-					
Maros Culture: Mokrin-Lalina humka (FARKAS and LIPTÁK, 1972)	-	0.203	0.857	-				
Maros Culture: Szőreg-C (FARKAS, 1975)	-	0.109	0.852	0.118	-			
Maros Culture: Szőreg-C1 (FARKAS, 1975)	-	0.270	1.366	0.119	-	-		
Maros Culture: Szőreg-C2 (FARKAS, 1975)	-	0.152	1.084	0.205	-	0.128	-	
Maros Culture: Szőreg-C3 (FARKAS, 1975)	-	0.288	0.546	0.379	-	0.726	0.538	-
Tumulus Culture: Tápé-Széntéglaégető (FARKAS and LIPTÁK, 1975)	0.136	0.183	1.063	0.218	0.143	0.197	0.077	0.474
4./ IRON AGE								
Bosut Culture: Hrtkovci-Gomolava (ZOFFMANN, in press)	0.161	0.357	0.728	0.233	0.177	0.380	0.288	0.431
Mezőcsát Culture (ZOFFMANN, in press)	0.282	0.326	0.532	0.470	0.303	0.680	0.415	0.421
Scythians (ZOFFMANN, in press)	0.302	0.220	0.930	0.506	0.333	0.641	0.412	0.366
Transdanubian Celts (ZOFFMANN, in press)	0.065	0.074	0.753	0.136	0.091	0.260	0.182	0.206
Slovakian Celts (ZOFFMANN, manuscript)	0.122	0.263	0.764	0.069	0.212	0.292	0.377	0.250

Table 2. Penrose distances of the Maros-Perjámos series (males).

	Maros Culture	Mokrin	Szőreg C	Szőreg C2
1./ NEOLITHIC PERIOD				
Lengyel Culture: Mórágy-B.1 (ZOFFMANN, manuscript)	0.574	0.494	0.680	0.843
South-Transdanubian Lengyel Culture (ZOFFMANN, 1984)	0.455	0.286	0.533	0.550
2./ COPPER AGE				
Bodrogkeresztúr Culture (ZOFFMANN, 1992)	0.071	0.111	0.121	0.164
Baden+Kostolac+Coţofeni Cultures (ZOFFMANN, 1992)	0.105	0.213	0.150	0.229
3./ BRONZE AGE				
Hurbanovo Culture: Bajč-Ragona (HANAKOVÁ et al., 1973)	0.275	0.369	0.324	0.532
Maros Culture: Mokrin-Lalina humka (FARKAS and LIPTÁK, 1972)	-	-		
Maros Culture: Szőreg-C (FARKAS, 1975)	-	0.213	-	
Maros Culture: Szőreg-C2 (FARKAS, 1975)	-	0.233	-	-
Tumulus Culture: Tápé-Széntéglaégető (FARKAS and LIPTÁK, 1975)	0.256	0.452	0.326	0.245
4./ IRON AGE				
Scythians (ZOFFMANN, in press)	0.310	0.500	0.313	0.420
Transdanubian Celts (ZOFFMANN, in press)	0.101	0.179	0.145	0.172
Slovakian Celts (ZOFFMANN, manuscript)	0.227	0.222	0.380	0.425

Table 3. Penrose distances of the Maros-Perjámos series (females).

	Maros Culture	Csanytelek	Mokrin	Szőreg C	Szőreg C3
1./ NEOLITHIC PERIOD					
Lengyel Culture: Mórágy-B.1 (ZOFFMANN, manuscript)	0.327	0.939	0.402	0.309	0.976
Tisza Culture (ZOFFMANN, 1992)	0.305	0.987	0.400	0.214	1.232
2./ COPPER AGE					
Baden+Kostolac+Coţofeni Cultures (ZOFFMANN, 1992)	0.225	0.489	0.297	0.358	0.409
3./ BRONZE AGE					
Maros Culture: Csanytelek (SZALAI, 1995)	-	-			
Maros Culture: Mokrin-Lalina humka (FARKAS and LIPTÁK, 1972)	-	0.768	-		
Maros Culture: Szőreg-C (FARKAS, 1975)	-	0.650	0.125	-	
Maros Culture: Szőreg-C3 (FARKAS, 1975)	-	0.580	0.557	-	-
Tumulus Culture: Tápé-Széntéglaégető (FARKAS and LIPTÁK, 1975)	0.096	0.632	0.169	0.162	0.392
4./ IRON AGE					
Bosut Culture: Hrtkovci-Gomolava (ZOFFMANN, in press)	0.229	0.431	0.417	0.333	0.499
Slovakian Celts (ZOFFMANN, manuscript)	0.195	0.459	0.240	0.293	0.638

geographical distances. Having come from oustside the Carpathian Basin, the Celts must have assimilated the peoples found here in great numbers. According to indirect evidence, the pre-Celtic populations of the eastern and western parts of the Carpathian Basin must have been biologically similar. Consequently, the Celtic invasion of the Carpathian Basin must have brought cultural and social rather than ethnic changes.

Conclusions

The above results, wich correspond in part to the previous anthropogical investigations (FARKAS, 1975; SZATHMÁRY, 1987) and are mostly in accordance with the archaeological data (TROGMAYER, 1985; ŞANDOR-CHICIDEAN and CHICIDEAN, 1989; KOVÁCS, 1994), unambiguously demonstrate the survival of the Copper Age population into the Bronze Age. This population, mixing to only a slight extent or not at all with alien populations that appeared in the Maros-Perjámos Culture (Csanytelek and Szőreg-C3), played an important role in the formation of the late Bronze Age Tumulus Culture and the early Iron Age Bosut Culture. Later, having survived the invasions of the Mezőcsát Culture and the Scythian populations, this autochthonous population somehow became one of the determining components of the late Iron Age Celtic civilisation of the Carpathian Basin.

References

FARKAS, GY. (1975): A Dél-Alföld őskorának paleoantropológiája. - (CSc thesis) Szeged.

FARKAS, GY. and LIPTÁK, P. (1968): Anthropologische Auswertung des frühbronzezeitlichen Gräberfeldes bei Battonya. - Acta Ant. Arch. Szeged. *12*, 53-61.

FARKAS, GY. and LIPTÁK, P. (1972): Antropološko istrživanje nekropole u Mokrinu iz ranog bronzanog doba. - Physical anthropological examination of a cemetery in Mokrin from the Early Bronze Age. In: GIRIĆ, M. (ed.): Mokrin, nekropola ranog bronzanog doba. - Diss. et Monograhie *11*, 239-271.

FARKAS, GY. and LIPTÁK, P. (1975): Anthropologische Auswertung des bronzezeitlichen Gräberfeldes bei Tápé. In: TROGMAYER, O. (ed): Das bronzezeitliche Gräberfeld bei Tápé. - Fontes Arch.Hung., Budapest, 229-268 pp.

HANÁKOVÁ , H., STLOUKAL, M. and TOČIK, A. (1973): Pohrebište ze starši doby bronzové v Bajči. - Das Gräberfeld aus der älteren Bronzezeit in Bajč.- Časopis Narodniho Muzea, prirod.odd. *142*, 58-88.

KOVÁCS, T. (ed.) (1994): Treasures of the Hungarian Bronze Age. - Budapest.

NEMESKÉRI, J. and SZATHMÁRY, L. (1987): An anthropological evaluation of the Indo-European problem: the anthropological and demographic transition in the Danube Basin. In: SKOMAL, S. N. and POLOME, E. (eds): Proto-Indo-European: The archaeology of a linguistic problem. - Inst. for the Study of Man, Washington, 88-121 pp.

ŞANDOR-CHICIDEAN, M. and CHICIDEAN, I. (1989): Zu den Grabsitten der Periam-Peçica-Kultur. - Dacia N.S. *33*, 5-38.

SZALAI, F. (1995): A Csanytelek-Palén feltárt középső bronzkori csontvázleletek anthropológiai vizsgálata. (Anthropological examination of the skeletons and cremated remains from the Middle Bronze Age excavated at the findspot Csanytelek-Palé (Southeast Hungary)). - MFMÉ - Studia Arch. *1*, 91-121.

SZATHMÁRY, L. (1987): Anthropologischer Abriss der Bronzezeit der Grossen Ungarischen Tiefebene. - DMÉ 1987, 55-67.

TROGMAYER, O. (1985): A szegedi nagytáj bronz- és kora-vaskorának néhány kérdéséről. (Über einige Probleme der Bronze- und Früheisenzeit des Szegeder Grossraumes.) - Acta Ant. et. Arch. *5*, 3-16.

ZOFFMANN, ZS. K. (1984): A Kárpát-medence neolitikus és rézkori embertani leleteinek főbb metrikus és taxonómiai jellemzői. (Main metric and taxonomic data of the anthropological finds dating from the Neolithic and Copper Ages in the Carpathian Basin.) - Anthrop.Közl. *28*, 79-9o.

ZOFFMANN, ZS. K. (1992): Kelet Kárpát-medence neolitikus és rézkori népességeinek embertani vázlata. - Cand.diss. Budapest.

ZOFFMANN, ZS. K. (1994): Kárpát-medence bronzkori embertani leleteinek taxonómiai és metrikus jellemzői. (Main metric and taxonomic data of the anthropological finds dating from the Bronze Age in the Carpathian Basin.) - Anthrop.Közl., *36*, 39-50.

ZOFFMANN, ZS. K.: Kárpát-medence vaskori embertani leleteinek főbb taxonómiai és metrikus jellemzői. (Main metric and taxonomic data of the anthropological finds dating from the Iron Age in the Carpathian Basin.) - Anthrop. Közl. (in press).

ZOFFMANN, ZS. K.: Kárpát-medence bronzkori és vaskori népességeinek embertani vázlata. - Budapest. (manuscript).

ACTA BIOL. SZEGED. 42, pp. 163-168 (1997)

FOR HOW LONG DOES THE HAND DEVELOP?

L. ALMÁSI, L. SZATHMÁRY and ZS. GUBA

Department of Human Biology, Kossuth Lajos University, Debrecen H-4010, P.O.B 6, Hungary

(Received: December 10, 1996)

Abstract

The aim of this study was to acquire data relating to the ontogenetic development of the hand by means of an examination of one length and four width hand measurements in a cross-sectional sample. The sampling was carried out in two semi-endogamous populations (Beszterec and Túrricse), located in the Erdőhát and Rétköz regions, respectively, whose historic-demographic backgrounds suggest that they fully represent the two areas. According to the census in 1990, the sampling involved 24 per cent of the inhabitants in Beszterec and 34 per cent of the inhabitants in Túrricse. The results indicate that in females some measurements become mature sooner, i.e. their dimensional stabilization is manifested earlier. The wrist breadth characteristic of adults has developed between 13 and 14 years of age in both sexes in both populations. There is no significant sexual difference in the stabilization of the hand length either (between 16 and 17 years of age). Thus, it is only the three breadth measurements on the metacarpus that provide an opportunity for estimation of the genetic background and the possible functional adaptation. From this point of view, there is only a slight difference between the two samples. The breadth measurements situated closer to the wrist stabilize at a definitely earlier age in the males of Túrricse than in the males of Beszterec. In females, the ontogenetic difference between the two samples is observed in the breadth measurements closer to the finger tip. The difference in stabilization age of the breadth dimensions are presumed to be moderated from wrist to finger tips in such a way that the adaptation phenomena can be recognized in the metacarpus.

Key words: hand form, age dependency

Introduction

In physical anthropology an individual over 18 years of age is traditionally considered to be an adult. An earlier investigation (ALMÁSI and SZATHMÁRY, 1994) suggested that the stabilization of some hand measurements takes place earlier. The aim of the present study was to contribute further data to the debate concerning whether this age limit can be accepted when examining hand dimensions. Besides determination of the age of stabilization, it was our intention to compare the tendency to stabilization of the hand dimensions in two populations considered to be semi-endogamous for different reasons, both located in the county of Szabolcs-Szatmár-Bereg.

Materials

Since the 1970-s, researchers at Kossuth University in Debrecen have been investigating small populations living in the Erdőhát and Rétköz regions (in the latter region in collaboration with the Bessenyei György Teachers' Training College). Both regions are located in the county of Szabolcs-Szatmár-Bereg (Fig. 1). The Rétköz region is bordered in the north by the River Tisza, and in the south by the Lónyai Canal. The Erdőhát region is part of the Szatmár-Beregi Plain, bordered by the Rivers Túr and Szamos and covered previously by extensive forests

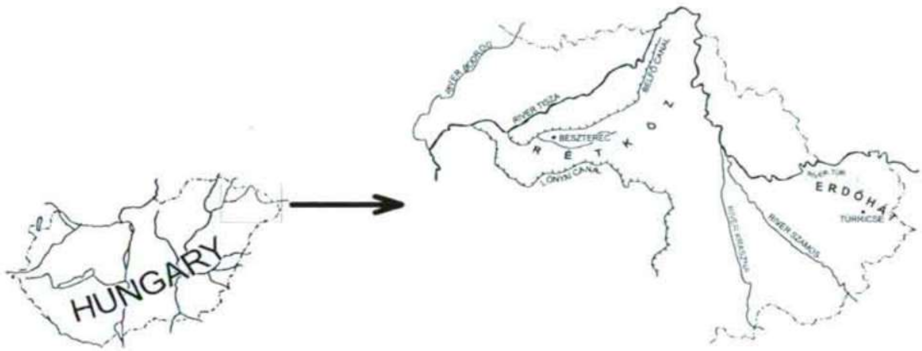

Fig. 1. Area of Rétköz and Erdőhát in Hungary.

Until the end of last century, the Rétköz region was a rather swampy area and the present villages were islands. People could therefore usually contact each other only by boat, and especially in summer. The marriage system was controlled by this hydro-geographical isolation and resulted in a certain degree of endogamy. The drainage of the inland water and flood zone in the Rétköz region by means of canalization was completed in the 1950-s, and thus the previous isolation is progressively disappearing (BORSY, 1961; MAROSI and SZILÁRD, 1969; PÓK, 1992).

Before the general canalization of the waterways started in the early decades of the 20th century, the Erdőhát region was also a marshy woodland. Usually only one-tenth of the fields remained dry during the annual flooding of the Rivers Szamos and Túr. Thus, the geographical isolation must have been an important factor influencing the population structure here, but on the other hand a subethnic differentiation of the population may also have contributed to the development of relative endogamy (MAROSI and MOLNÁR, 1966).

The present project concentrated on the villages of Beszterec and Túrricse. Both villages belong in the small population category. The compositions of the populations are shown in Table 1:

Table 1. Samples examined

Ages (years)	Túrricse						Beszterec					
	Males		Females		Total		Males		Females		Total	
	N	%*	N	%*	N	%*	N	%*	N	%*	N	%*
0-24	46	41	48	49	94	45	77	39	95	44	172	42
25-	24	12	34	15	58	14	74	25	121	34	195	30
Total	70	33	82	20	152	24	151	31	216	38	367	35

* Percentage of the total number in the given age group (1990 census)

Methods

We measured the dimensions of the hand from an anatomical aspect (SZATHMÁRY 1976) slightly different from the approach of SCHLAGINHAUFEN (1932-33). The examined dimensions are listed in Fig. 2.

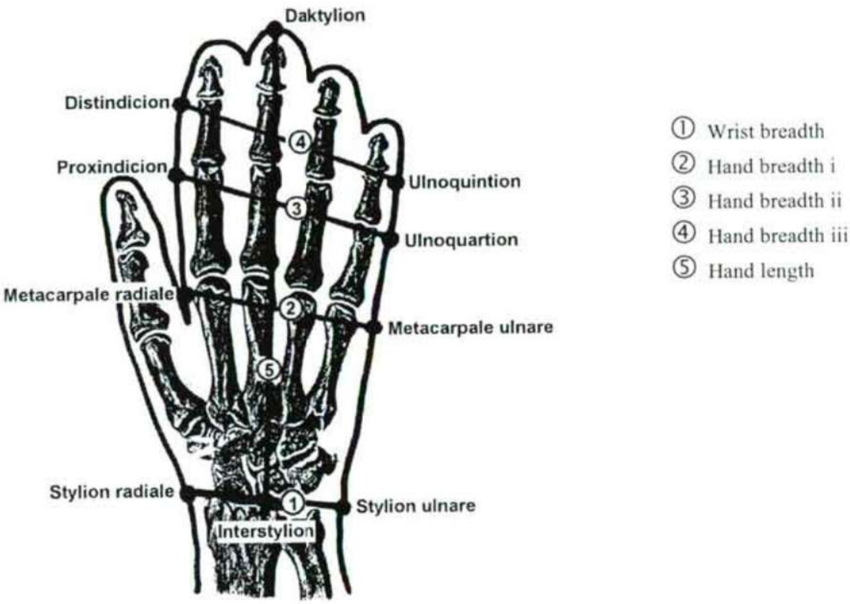

Fig. 2. Hand dimensions examined.

Only the dimensions of the right hand were analyzed, and the bilateral difference was neglected (cf. FUSTE, 1951; THoma, 1952; EIBEN, 1967).

In the first step, for determination of the age of stabilization we charted the distribution of the data for each hand measurement. This set of points was approximated by a six-order polynomial curve.

In the second phase of the accurate calculation of the age of stabilization, the Gauss method was used. The set of ages was divided into two parts, and for both parts a regression line (a first approximation line) and the correlation of the lines were calculated as follows:

$$\eta = \sqrt{1 - \frac{s^2}{s_x s_y}}$$

where s, s_x and s_y are the variances of [y - (ax+b), x, y].

By changing the age limit between the two age groups, we determined the maximum sum of the two correlations; this division age coincides with the accurate age of stabilization (FAUX and PRATT, 1979).

The distribution of the data and their approximation by a six-order polynomial curve are demonstrated in the following Figures:

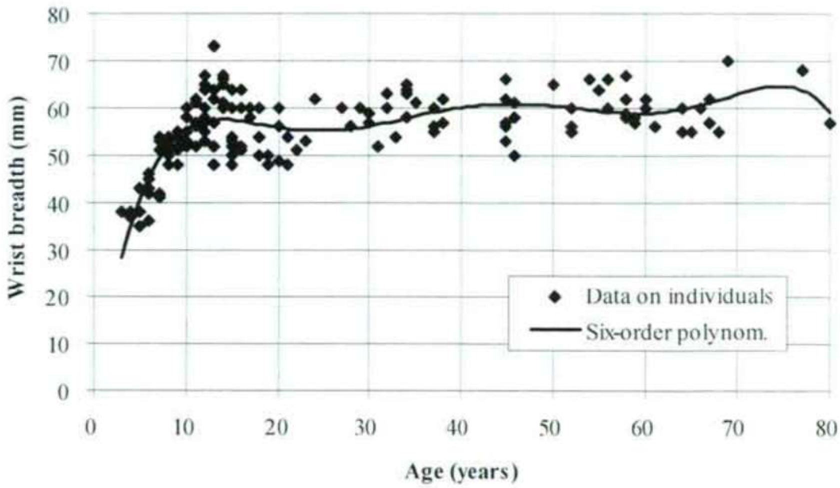

Fig. 3. Distribution of data (wrist breadth, males, Beszterec).

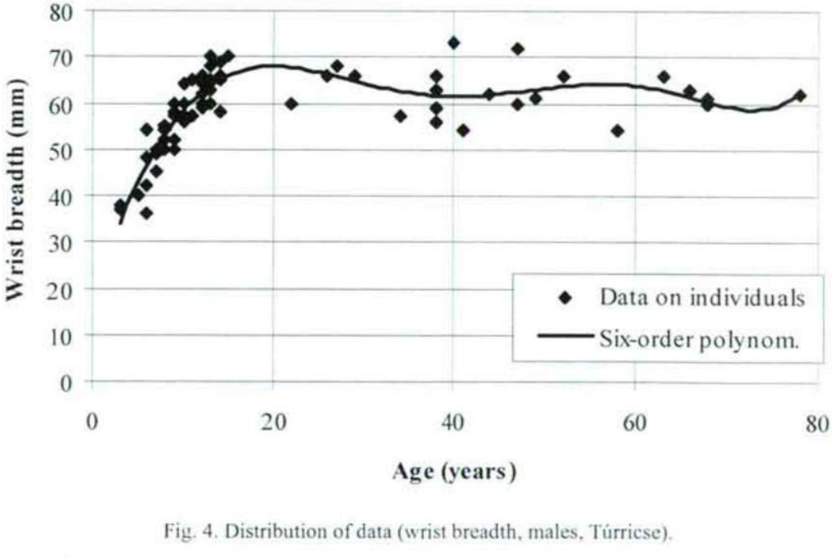

Fig. 4. Distribution of data (wrist breadth, males, Túrricse).

Results

The results are shown in the following Table:

Table 2. Age of stabilization in hand

Dimensions	Age of stabilization (years)			
	Túrricse		Beszterec	
	Males	Females	Males	Females
Wrist breadth	13-14*	13-14*	14	13
Hand breadth i	14-15*	13-14*	17	13
Hand breadth ii	15-17*	12-13*	18	13
Hand breadth iii	17-19*	17-18*	17	16
Hand length	16-17*	16-17*	16	16

* The age of stabilization is given only in age intervals because of the small sample size

Conclusions

The following differences were found between the results on the Beszterec and Túrricse samples:

1. Stabilization of the dimensions Hand breadth i and Hand breadth ii takes place at a younger age in the males in Túrricse.
2. Hand breadth iii is stabilized at an older age among the females in Túrricse.

Besides the differences mentioned above, the two populations exhibit many similarities:

1. Stabilization of the hand dimensions appears systematically at a younger age in females than in males.
2. The wrist breadth becomes stable at a surprisingly early age (between 13 and 14 years) in both sexes.
3. The greatest sexual difference can be observed in the knuckles of the proximal phalanges (Hand breadth ii).
4. No significant sexual difference can be detected in the stabilization of the hand length (between 16 and 17 years of age).
5. Main conclusion: Stabilization of the hand dimensions is completed by the age of 18-19 both sexes.

References

ALMÁSI, L. and SZATHMÁRY, L. (1994): Dimensional development of the hand — AUXOLOGY'94, Humanbiol. Budapest. *25*, 363-368.

BORSY, Z. (1961): A Nyírség természeti földrajza (Geography of the Nyírség). — Akadémiai Kiadó, Budapest.

Census 1990: Az 1990. évi népszámlálás: Szabolcs-Szatmár-Bereg megye adatai (The population census in 1990: The census data for Szabolcs-Szatmár-Bereg county). — KSH, Budapest, 1992.

EIBEN, O. (1967): Handformenuntersuchungen. — Mitt. d. sekt. Anthrop. *21*, 23-42.

FAUX, F. and PRATT, M. (1979): Computational geometry for design and manufacture. — Ellis Horwood, Sussex.

FUSTÉ, M. (1951): Die Handform dreier Berufsgruppen. - Homo *2*, 164-167.

MAROSI, S. and SZILÁRD, J. (1969): A tiszai Alföld (Great Plain along the Tisza). In: PÉCSI, M. (ed): Magyarország tájföldrajza. — Akadémiai Kiadó, Budapest.

PÓK, J. (1992): Szabolcs vármegye katonai leírása 1782-1785 (Military description of Szabolcs county 1782-1785). — A Szabolcs-Szatmár-Bereg Megyei Levéltár Kiadványai, II. Közlemények, *6*.

SCHLAGINHAUFEN, O. (1933): Beobachtungen über die Handform bei Schwizern. — Bulletin d. Schweiz. Ges. f. Anthrop. u. Ethn. *9*, 29-52.

SZATMÁRY, L. (1976): Módszertani javaslat az emberi kéz formáinak valamint a köröm és az ujjhegy anatómiai elvű megítéléséhez: Tervezet a szamosangyalosi kutatásokhoz (A methodological proposal for the anatomical estimation of the hand form, the nail and the finger-tip: Planned research-work in Szamosangyalos). — Kossuth Lajos Tudományegyetem, Debrecen, Humánbiológiai Csoport, (manuscript)

THOMA, A. (1952): Kézformavizsgálatok. - Recherches sur la forme de la main. — Annales Univ. Biol. Univ. Hung. Pars Debreceniensis *2*, 290-309.

ACTA BIOL. SZEGED. 42, pp. 169-173 (1997)

SELECTED PHYSICAL FITNESS AND PHYSICAL ACTIVITY PARAMETERS OF THE HUNGARIAN SCHOOLCHILDREN (TWELVE AND FIFTEEN YEAR-OLD BOYS AND GIRLS)

A. BARABÁS and I. MAKSZIN

Hungarian University of Physical Education, H-1123, Budapest, Alkotás u. 44.

(Received: December 10, 1996)

Abstract

Hungary was one of the countries participating in the European Comparative Youth Study of the International Committee of Sport Pedagogy. In the project "Sportive Lifestyle, Motor Performance and Olympic Ideal of Youth in Europe", 12 and 15-year-old girls and boys were investigated by means of physical fitness tests and questionnaires. The number of samples was 444. The research methods involved motor performance tests (Eurofit, 1993), a "Life-style questionnaire" and an "Olympic ideas questionnaire". The questionnaires were devised by the group co-ordinating the research project and were justified in previous studies with a focus on the place of physical activity and sport during children's daily life. The physical activity index relating to frequency and involvement revealed significant differences in favour of boys. In physical performance tests, the results of the selected sample were consistently higher than the Hungarian reference values.

Key-words: physical fitness, physical activity, Hungarian adolescents, physical performance tests.

Introduction

The International Committee of Sport Pedagogy initiated and organised the study "Sportive Lifestyle, Motor Performance and Olympic Ideal of Youth in Europe" (NAUL et al., 1995). Co-ordinators: L. ALMOND (Loughborough, Great Britain), R. NAUL (Essen, Germany), M. PIERON (Liege, Belgium) and R. TELAMA (Jyvaskyla, Finland). Contributing sport and health science institutions: Loughborough (Great Britain), Tallin (Estonia), Budapest (Hungary), Lisbon (Portugal), Essen (Germany), Liege (Belgium), Prague (Czech Republic), and Jyvaskyla (Finland).

Several scientific and professional meetings have focused on the increasing importance of a healthy lifestyle, which is currently linked to the quality of life and health status. "Lifestyle comprises the aggregate of an individual's behaviours, actions and habits which can affect personal health (e.g. smoking, diet, habitual physical activity)." (BOUCHARD et al., 1990).

Another reason for the interest in this research is that it has been clearly shown that regular participation in physical activity is associated with a large number of physical, physiological and psychological benefits. Physical fitness depends on many factors, such as heredity, constituents and maturation level. Physical fitness is the product resulting from a certain level of physical activity, which is a process. BLAIR (1995) gathered data showing that physical fitness (product) is improved by regular physical activity (process). If children are provided with an opportunity to engage in supplementary physical activity beyond the usual school physical education lessons, their physical fitness will improve. This should exert a positive effect on health, and favours the installation of active lifestyle habits which may continue into adulthood (BLAIR et al., 1989). The prediction of future exercise behaviour from actual behaviour is at the focus of research attention. Some authors found a significant positive correlation between the physical activity during childhood and adolescence (ARMSTRONG, 1991; TELAMA et al., 1994). There is a long-term effect of a voluntary or organised physical activity on the belief in health effects, on the enjoyment and on later participation. It was important to the team of researchers to assess not only the actual physical fitness, but also the place and importance of organised and non-organised sports activities, in order to gauge their level of practical involvement within the framework of a changing European Society, with particular focus on the issue of the uncertain future of youth.

The justification of the age groups examined as follows:

These ages are important in terms of the attrition from sport activities, a large proportion of children dropping out of sport activities in their teens (ORLICK,1974). These ages are related to the end of the prepubertal period and the beginning of adolescence. At this stage, children are trying to affirm their character and frequently oppose the ideas and values of adults. A change in their lifestyle may also be linked to this need for independence at about 15 years of age. Early adolescence is a particularly interesting time to study changes in self-perceptions (HARTER, 1990). It has been suggested to be a time of gender-role intensification, a time during which males and females adopt more extreme differences in their activities and self-perceptions (ECCLES et al., 1989).

The research methods used were motor performance tests (Eurofit, 1993), a "Life-style questionnaire" and an "Olympic ideas questionnaire". These questionnaires were devised by the co-ordinating group (ALMOND, NAUL, PIERON and TELAMA) and were justified in previous studies with a focus on the place of physical activity and sport in children's daily life.

Data collection was finished in early 1996.

Results and discussion

For determination of the physical activity index, the basic data were collected from the life-style questionnaire. The information related to the

- frequency of activities in club,
- frequency of unorganised activities,
- frequency of physical activity at least 20 min.,

- amount of intensive hours,
- competitions.

There were different answers for these five items. Based on the coding list, the sum of the maximal points was 20.

Hungarian pupils have got the following values:

12-year-old boys: 14, i.e. 70%,

15-year-old boys: 13, i.e. 65%,

12-year-old girls 13, i.e. 65%,

15-year-old girls 12, i.e. 60% of the maximal value.

The physical activity index reflects the age and gender differences: younger children are more active than older ones and boys are more active then girls; the least active are the 15-year-old girls. These phenomena correspond to our previous findings (BARABÁS, 1989; EIBEN et al., 1991).

Some physical characteristics and one of the measured physical performance value (data from "The Hungarian National Growth Study", EIBEN et al., 1991) are presented in Table 1. The sampling investigated 27,274 boys and girls with cohort size around thousand in every age group.

Table 1. Antropometric and physical performance values in "The Hungarian National Growth Study" (EIBEN et al., 1991).

Variables	Mean	SD	Min	Max	N
12-year-old BOYS					
Height (cm)	149.01	7.55	127.9	175.8	1351
Weight (kg)	39.49	9.16	23	87	1351
Broad jump (cm)	150	19.4	80	220	1107
15-year-old BOYS					
Height (cm)	168.83	8.02	140.2	194.2	1730
Weight (kg)	57.98	10.97	31	120	1730
Broad jump (cm)	185	25.2	110	260	1551
12-year-old GIRLS					
Height (cm)	150.66	7.57	127	174.2	1374
Weight (kg)	40.86	9.21	20	89.5	1374
Broad jump (cm)	145	20.6	60	210	1055
15-year-old GIRLS					
Height (cm)	161.16	6.34	137.4	191.9	1563
Weight (kg)	53.00	8.80	26.5	98	1563
Broad jump (cm)	155	20.0	70	250	1224

Table 2 shows the anthropometric data and results of physical performance tests of Hungarian students in European Youth Project '96 corresponding to their physical fitness status. The group-numbers (age and gender) of investigated sample in this project was above hundred in the case of Hungarian subjects as in the case of other countries subjected. The physical fitness results of different participants of European Youth Project '96 will be discussed in the near future.

Table 2. Anthropometric and physical performance values of selected sample .

Variables	Mean	SD	Min	Max	N
12 / BOYS					
Age (years)	11.89	0.84	10	13	102
Height (cm)	154.35	10.18	125	176	102
Weight (kg)	43.11	8.40	28	65	102
BMI	18.01	2.08	14.03	24.17	102
20 m shuttle run (N)	36.67	4.03	29.0	58.7	100
Curl up (sec)	107.8	42.20	28.0	240.0	95
Broad jump (cm)	173.61	33.33	16.0	245	100
Sit & reach (cm)	27.79	9.91	9	47	99
5 jump (max) (cm)	880.29	113.97	660	1140	101
15 / BOYS					
Age (years)	14.77	0.46	14	16	114
Height (cm)	173.01	8.16	150	192	114
Weight (kg)	63.36	12.95	38	110	114
BMI	20.93	3.41	14.57	37.18	114
20 m shuttle run (N)	37.70	3.85	28.0	59.0	114
Curl up (sec)	134.12	45.68	38.0	311.0	114
Broad jump (cm)	198.55	23.45	120	240	114
Sit & reach (cm)	8.72	7.93	-9	32	114
5 jump (max) (cm)	1017.48	104.61	650	1290	114
12 / GIRLS					
Age (years)	11.80	0.86	10	13	117
Height (cm)	155.11	8.59	130	176	117
Weight (kg)	42.54	7.41	26	63	117
BMI	17.56	1.95	12.84	22.86	117
20 m shuttle run (N)	34.03	3.09	26.0	41.8	113
Curl up (sec)	85.24	41.64	0.56	222.0	116
Broad jump (cm)	167.09	23.43	100	215	116
Sit & reach (cm)	32.45	11.82	10	59	115
5 jump (max) (cm)	849.76	112.26	520	1145	116
15 / GIRLS					
Age (years)	14.47	0.52	14	16	111
Height (cm)	165.27	6.78	140	183	111
Weight (kg)	54.40	7.75	38	78	111
BMI	19.89	2.42	14.69	27.40	111
20 m shuttle run (N)	35.95	6.48	28.3	99.9	111
Curl up (sec)	95.98	40.58	0.50	235.0	110
Broad jump (cm)	176.07	20.08	50	228	110
Sit & reach (cm)	25.42	6.01	12	41	110
5 jump (max) (cm)	864.97	134.46	151	1084	111

Conclusions

The results relating to the children's participation in leisure activities and the importance placed on such activities demonstrated that girls from both age groups were consistent in giving a high rating in terms of importance and participation in a cultural activity such as reading, and in a social activity such as talking to friends. In the area of participation in competitive and unorganised sports, greater percentages of boys than girls reported that they were taking part in sports activities. The physical activity index appeared to give "more real" results. The data relating to frequency and intensity of involvement revealed significant differences in favour of boys in very frequent and intensive activities. In both age groups, girls were characterised by infrequent participation and by activities of low intensity. As children become older, there is a general pattern revealing that the importance of involvement and agreement with the importance of the activities increase. The anthropometric and physical performance values of the Hungarian children in the European Youth Study '96 were higher than the reference values from the Hungarian National Growth Study. Since there are differences between the subject numbers in the two investigations, the results are not comparable statistically. Significant differences between the results from different countries can be due to social differences.

References

ARMSTRONG, N. (1991): Pupil's perceived physical competence and its implications for the new PE curriculum. - Physical Education Association Research. Supplement *7*, 1-5.

BARABÁS, A. (1989): Motor performance of Hungarian schoolchildren. In: OSEID, S. and CARLSON, K. (eds): Children and Exercise XIII. - Human Kinetics Books, Champaign, Ill. pp. 29-37.

BLAIR, S. (1995): Physical activity leads to fitness and pays off. - The Physician and Sportmedicine *11*, 87-94.

BLAIR, S., CLARK, D., CURETON, K. and POWELL, K. (1989): Exercise and fitness in childhood. Implications for a lifetime of health. In: GISOLFI, C. and LAM, D. (eds): Perspectives in exercise science and sports medicine. Vol. 2: Youth exercise and sport. - Benchmark Press, Indianapolis, 401-430 pp.

BOUCHARD, C., SHEPHARD, R., STEPHENS, T., SUTTON, J. and MCPHERSON, B. (1990): Exercise, fitness and health. - Champaign, Ill. Human Kinetics.

ECCLES, J. S., WIGFIELD, A., FLANAGAN, C. A., MILLER, C., REUMAN, D. A. and YEE, D. (1989): Self-concept, domain values and self-esteem: Relations and changes at early adolescence. - J. Personality *57*, 283-310.

EIBEN, O. G., BARABÁS, A. and PANTÓ, E. (1991): The Hungarian National Growth Study. I. Reference data on the biological developmental status and physical fitness of 3-18 year-old Hungarian youth in the 1980s. - Humanbiologia Budapestinensis *21*, 123.

Eurofit, European Tests of Physical Fitness (1993). - Council of Europe, Committee for the Development of Sport (CE, CDDS), Strasbourg.

HARTER, S. (1990): The perceived competence scale for children. - Child Development *53*, 87-97.

NAUL, R., POHL, A., TELAMA, R., ALMOND, L. and PIERON, M. (1995): Sportive lifestyle, motor performance and Olympic ideal of youth in Europe: Preliminary notes on a new comparative youth sport study. - ICSP. International Committee of Sport Pedagogy, Newspaper *10*, 2-7.

ORLICK, T. D. (1974): The athletic drop-out: A high price of inefficiency. - Canadian Association for Health, Physical Education Recreation Journal, 21-27.

TELAMA, R., LAAKSO, L. and YANG, X. (1994): Physical activity and participation in sports of young people in Finland. - Scandinavian Journal Medicine and Science in Sports *4*, 65-74.

ACTA BIOL. SZEGED. 42, pp. 175-181 (1997)

BODY PROPORTIONS AND SEXUAL MATURATION

É. B. BODZSÁR

Department of Biological Anthropology, Eötvös Loránd University, H-1088 Budapest, Puskin u. 3., Hungary

(Received: January 5, 1997)

Abstract

This study compared the body proportions of pre- and postmenarcheal girls of the same chronological age. The results are based on the data of relative longitudinal, transversal and circumference measurements representing the proportional differences and changes in the trunk and the limbs. The subgroups were compared by means of the Anova test; the multiple comparisons were tested by SCHEFFÉ's formula.

Analytical considerations revealed that there are significant differences in body shape between the earlier and later maturers. The length-breadth proportions of the chest and pelvic region differ significantly: premenarcheal girls have a more linear trunk. The menarche occurs earlier in those girls who have a more developed chest and broader hips in relation to the shoulder breadth, as well as a proportionally longer trunk and shorter extremities.

Key words: growth, body dimensions, body proportions, maturation, menarche.

Introduction

One of the stages of ontogenesis which is accompanied by the most dynamic changes is puberty, the intermediate stage between childhood and youth. In this stage of life, the growth of the bone and musculature systems and also the development of the reproductive organs become very intensive.

The intensive quantitative changes and the accelerated development of the sexual organs in this hormonally unbalanced age show up in great differences between children of the same sex but with different growth patterns.

A higher developmental level of the reproductive organs is indicated in menarcheal girls, but on the other hand the menarche indicates the end of the intensive growth of the bone and musculature systems (TANNER, 1961).

The differences between the absolute body measurements of postmenarcheal and premenarcheal girls of the same age indicate that during the maturation the growth processes are more intensive and faster in girls who mature earlier and therefore whose growth and development are finished earlier (FRISCH and REVELL, 1970; BODZSÁR, 1977, 1982; DANKER and BENTZ, 1982; FARKAS and SZEKERES, 1982; PÁPAI, 1996). Thus, it seems possible that differences can be found in the body proportions of children maturing earlier or later in spite of their having the same chronological age.

The purpose of this paper was to furnish data on the growth kinetics on the basis of some differences in body shape of pre- and postmenarcheal girls of the same chronological age.

Subjects and methods

The cross-sectional growth study was carried out in 23 settlements in the Bakony region in Western Hungary (BODZSÁR, 1991). The distribution of the pre- and postmenarcheal girls according to age groups is summarized in Table 1. The sample represents rural children living in a highly industrialized environment.

Table 1. Subjects.

Age (yr.)	Postmenarcheal girls	Premenarcheal girls
10.5	6	126
11.0	7	132
11.5	21	134
12.0	37	104
12.5	53	85
13.0	83	46
13.5	118	26
14.0	121	19
14.5	129	5

The absolute dimensions were measured with consideration to the internationally recognized standards of MARTIN and SALLER (1966) and the IBP recommendations (WEINER and LOURIE, 1969). Of these variables, 13 relative measurements and indices were calculated.

The differences between postmenarcheal and premenarcheal girls and also the successive age groups were studied by means of the two-way ANOVA test. In the pair-wise comparisons, SCHEFFÉ's contrasts were used to reveal significant differences (HAJTMAN, 1968).

Results and discussion

There are no statistically significant differences in the *length-breadth proportions* of the trunk in postmenarcheal girls of different ages, whereas in premenarcheal girls there are significant changes with age. The ratios of the biacromial breadth, the chest circumference and the biiliocristal breadth to the sitting height reveal that the premenarcheal girls have a more linear trunk. The smallest differences are to be found in the length-breadth proportions of the trunks of the postmenarcheal and premenarcheal girls in the shoulder region, whereas in the chest and pelvic region there are significant differences in every age group, premenarcheal girls having a more linear trunk (Table 2).

In the *proportions of the breadth measurements* of the three regions of the trunk, there are no significant changes with age in either postmenarcheal or in premenarcheal girls. At the same time, the ratio of the mesosternal breadth to the biacromial breadth and the ratio of the biiliocristal width to the biacromial breadth differ significantly in the postmenarcheal and premenarcheal girls (Table 3). The menarche occurs earlier in girls who have a more developed chest and broader hips relative to the shoulder breadth.

Table 2. Length-breadth proportions of the trunk.

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, p <
Biacromial breadth/Sitting height (%)							
41.17	0.15	1.94	10.5	42.16	0.77	2.62	n.s.
41.71	0.18	2.27	11.0	42.34	0.66	2.30	n.s.
41.30	0.15	1.87	11.5	41.18	0.25	1.66	n.s.
41.10	0.17	1.90	12.0	41.58	0.29	1.77	n.s.
41.80	0.22	2.08	12.5	41.55	0.27	2.06	n.s.
42.03	0.26	1.86	13.0	41.79	0.23	2.11	n.s.
40.90	0.37	2.07	13.5	41.69	0.18	2.12	n.s.
40.83	0.45	1.97	14.0	41.24	0.21	2.40	n.s.
40.18	0.67	1.51	14.5	41.60	0.29	2.34	n.s.
Chest circumference/Sitting height (%)							
89.75	0.51	6.34	10.5	94.23	0.77	4.87	0.050
91.13	0.56	6.98	11.0	94.90	0.80	6.94	0.050
91.31	0.48	5.85	11.5	94.06	0.87	6.35	0.050
92.07	0.63	6.84	12.0	94.89	0.82	5.71	0.050
92.83	0.60	5.76	12.5	93.87	0.83	6.32	0.050
92.07	0.68	6.92	13.0	94.50	0.83	6.44	0.050
91.15	0.73	5.00	13.5	94.95	0.65	6.55	0.050
91.42	0.70	5.69	14.0	94.68	0.62	6.33	0.050
90.39	0.83	5.22	14.5	94.31	0.83	6.65	0.050
Biiliocristal width/Sitting height (%)							
29.91	0.20	2.59	10.5	31.44	0.42	2.20	0.050
30.43	0.17	2.10	11.0	32.12	0.48	1.46	0.050
30.59	0.18	2.33	11.5	31.59	0.40	2.03	0.050
30.92	0.18	2.00	12.0	31.60	0.28	1.74	0.050
30.54	0.24	2.32	12.5	31.32	0.35	2.62	0.050
30.25	0.28	1.99	13.0	31.74	0.28	2.63	0.050
30.76	0.47	2.59	13.5	31.91	0.20	2.36	0.050
30.36	0.44	2.39	14.0	31.81	0.20	2.33	0.050
29.85	0.62	1.59	14.5	32.20	0.26	2.05	0.050

The differences between the occurrence of the adolescent growth spurt in the different length measurements can be observed very clearly via the relative sitting height and the relative iliospinal height (Table 4). Analysis of the *proportions of the trunk extremities* demonstrated that postmenarcheal girls have a proportionally longer trunk and shorter extremities than premenarcheal girls, i.e. the occurrence of menarche is preceded by an intensive adolescent growth in sitting height.

There are no significant changes with age in the *proportions of the extremity lengths* (Table 5) in either the postmenarcheal or the premenarcheal girls and there are no differences in these proportions between matured and non-matured girls of the same age. This fact reveals that the lower and upper extremities undergo longitudinal growth in parallel. On the other hand, the postmenarcheal girls have broader and thicker lower and upper extremities in every age group than the premenarcheal girls.

Table 3. Breadth-breadth proportions of the trunk

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, p <
Mesosternal breadth/Biacromial breadth (%)							
69.07	0.34	4.28	10.5	72.18	0.71	4.45	0.050
69.12	0.32	3.98	11.0	71.89	0.56	4.14	0.050
69.24	0.36	4.41	11.5	70.65	0.70	4.42	0.050
69.24	0.33	3.69	12.0	70.60	0.71	4.43	0.050
69.58	0.38	3.60	12.5	70.83	0.51	3.88	0.050
69.70	0.63	4.50	13.0	71.22	0.56	5.21	0.050
69.33	0.63	3.45	13.5	71.47	0.36	4.15	0.050
69.72	0.74	3.66	14.0	71.57	0.44	4.94	0.050
68.86	0.75	3.03	14.5	71.22	0.55	4.41	0.050
Biiliocristal width/Biacromial breadth (%)							
72.78	0.50	6.21	10.5	74.63	0.76	4.80	0.050
73.45	0.41	5.20	11.0	75.96	0.85	4.05	0.050
73.72	0.41	4.97	11.5	75.23	0.86	4.72	0.050
73.48	0.37	4.10	12.0	75.89	0.77	4.68	0.001
73.22	0.57	5.43	12.5	75.43	0.74	5.56	0.001
74.37	0.52	4.74	13.0	76.10	0.78	5.21	0.050
74.37	0.56	5.47	13.5	76.60	0.44	5.12	0.050
74.97	0.67	4.69	14.0	77.15	0.50	5.78	0.050
74.29	0.62	3.98	14.5	77.59	0.71	5.61	0.050

Table 4. Proportions of the trunk extremities.

Premenarcheal girls				Postmenarcheal girls			
Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Mean	$s_{\bar{x}}$	S.D.	t-test, p <
Sitting height/Body height (%)							
51.51	0.10	1.25	10.5	52.19	0.41	1.49	0.050
51.51	0.10	1.24	11.0	52.28	0.35	1.98	0.050
51.71	0.11	1.38	11.5	52.05	0.24	1.24	0.050
51.45	0.12	1.38	12.0	52.88	0.21	1.31	0.050
51.43	0.14	1.36	12.5	52.33	0.18	1.39	0.005
51.42	0.20	1.41	13.0	52.24	0.15	1.40	0.050
51.50	0.25	1.38	13.5	52.14	0.12	1.47	0.050
51.30	0.30	1.24	14.0	52.32	0.12	1.40	0.050
51.74	0.34	1.29	14.5	52.05	0.16	1.33	n.s.
Iliospinal height/Body height (%)							
57.31	0.17	1.81	10.5	57.23	0.60	1.96	n.s.
58.01	0.14	1.83	11.0	57.05	0.31	1.83	0.050
58.10	0.14	1.72	11.5	57.29	0.32	1.64	0.050
58.32	0.15	1.83	12.0	58.07	0.24	1.50	n.s.
58.21	0.17	1.69	12.5	58.11	0.25	1.73	n.s.
58.48	0.19	1.77	13.0	58.30	0.23	2.12	n.s.
57.89	0.36	1.98	13.5	58.04	0.18	2.13	n.s.
58.24	0.46	1.92	14.0	58.00	0.18	2.10	n.s.
58.29	0.43	1.96	14.5	58.02	0.29	2.14	n.s.
Iliospinal height/Sitting height (%)							
110.48	0.41	5.11	10.5	109.80	0.74	5.73	n.s.
112.68	0.38	4.78	11.0	111.44	0.60	5.58	0.050
112.51	0.42	5.17	11.5	111.16	0.72	5.12	0.050
113.49	0.49	5.42	12.0	112.16	0.71	5.38	0.050
113.28	0.49	4.73	12.5	112.48	0.66	5.00	0.050
113.70	0.81	5.78	13.0	112.28	0.56	5.27	0.050
112.54	0.81	5.99	13.5	111.24	0.47	5.51	0.050
112.75	0.72	5.80	14.0	111.77	0.47	5.33	0.050
111.60	0.64	5.11	14.5	111.88	0.60	5.63	n.s.

Table 5. Proportions of the extremities.

Premenarcheal girls Mean	$s_{\bar{x}}$	S.D.	Age (yr.)	Postmenarcheal girls Mean	$s_{\bar{x}}$	S.D.	t-test, p <
Upper extremity length/Iliospinal height (%)							
75.47	0.24	3.07	10.5	75.72	0.67	2.38	n.s.
75.26	0.23	2.93	11.0	75.76	0.65	2.72	n.s.
74.91	0.25	3.04	11.5	75.40	0.62	3.10	n.s.
75.05	0.29	3.16	12.0	75.75	0.50	3.14	n.s.
75.16	0.32	3.05	12.5	75.76	0.43	3.27	n.s.
75.71	0.62	3.37	13.0	75.52	0.40	3.76	n.s.
76.41	0.63	3.88	13.5	75.34	0.27	3.11	n.s.
76.08	0.61	3.44	14.0	75.75	0.32	3.64	n.s.
75.34	0.41	3.17	14.5	75.01	0.35	2.85	n.s.
Biepicondylar humerus/Upper extremity length (%)							
9.00	0.04	0.56	10.5	9.15	0.12	0.62	n.s.
8.99	0.04	0.54	11.0	9.15	0.10	0.47	n.s.
8.86	0.05	0.60	11.5	8.97	0.11	0.54	n.s.
8.80	0.05	0.61	12.0	8.86	0.10	0.65	n.s.
8.70	0.06	0.59	12.5	8.78	0.06	0.48	n.s.
8.72	0.12	0.66	13.0	8.79	0.06	0.63	n.s.
8.70	0.09	0.49	13.5	8.78	0.04	0.53	n.s.
8.58	0.11	0.48	14.0	8.77	0.05	0.61	n.s.
8.64	0.12	0.63	14.5	8.77	0.06	0.54	n.s.
Biepicondylar femur/Iliospinal height (%)							
10.35	0.05	0.63	10.5	10.40	0.10	0.50	n.s.
10.20	0.04	0.55	11.0	10.30	0.11	0.49	n.s.
10.16	0.05	0.65	11.5	10.23	0.10	0.53	n.s.
10.09	0.06	0.68	12.0	10.16	0.09	0.58	n.s.
10.03	0.06	0.59	12.5	10.15	0.09	0.68	n.s.
9.95	0.11	0.66	13.0	9.97	0.07	0.64	n.s.
9.88	0.09	0.65	13.5	9.96	0.06	0.63	n.s.
9.64	0.13	0.58	14.0	9.94	0.06	0.68	n.s.
9.67	0.11	0.57	14.5	9.92	0.07	0.64	n.s.
Upper arm circumference/Upper extremity length (%)							
32.13	0.31	3.84	10.5	33.88	0.46	2.62	n.s.
31.75	0.29	3.75	11.0	33.60	0.49	2.63	n.s.
31.72	0.33	3.96	11.5	33.07	0.47	2.87	n.s.
31.85	0.37	3.75	12.0	33.55	0.50	3.74	0.050
31.97	0.37	3.46	12.5	33.77	0.51	3.88	0.050
31.53	0.47	3.99	13.0	32.28	0.40	3.68	0.050
30.92	0.51	3.79	13.5	33.34	0.36	3.62	0.005
31.64	0.57	3.69	14.0	33.08	0.37	3.86	0.050
32.06	0.49	3.59	14.5	33.10	0.48	3.89	0.050
Thigh circumference /Upper extremity length (%)							
52.73	0.39	4.86	10.5	57.00	0.43	3.51	0.005
52.61	0.43	4.79	11.0	56.78	0.71	4.95	0.005
52.11	0.38	4.82	11.5	55.78	0.87	4.36	0.001
52.00	0.48	4.65	12.0	55.94	0.69	4.22	0.001
51.90	0.47	4.51	12.5	55.10	0.68	4.91	0.001
52.07	0.58	4.49	13.0	55.02	0.56	4.94	0.001
52.44	0.53	4.53	13.5	55.67	0.48	4.47	0.001
52.68	0.40	4.80	14.0	55.68	0.53	4.98	0.005
52.78	0.43	4.74	14.5	55.56	0.58	4.58	0.005

Conclusions

The interpretation of the proportional differences to be found in the body dimensions of postmenarcheal and premenarcheal girls can be approached from two directions.

The results clearly show that the different stages of ontogenesis can only be reached after certain quantitative increases. As the growth processes of the different body measurements are dependent, the whole process of growth is well organized and thus it seems very likely that the development of certain body proportions is required for a higher developmental stage to be obtained. The menarche occurs earlier in girls who can be characterized by a stumpy, more robust body shape.

Approaching the problem from the other direction, it can be stated that the reason why the postmenarcheal and premenarcheal girls of the same age differ in their body proportions is that the physique genetically influences the growth as well as the maturation processes: a certain physique predestines to an early, and another physique a late maturation.

Acknowledgement

This study was supported by the National Scientific Research Foundation (OTKA grant No. 1/6/T 013098), for which the author is grateful.

References

BODZSÁR, É. B. (1977): Recent data to the physical development of adolescent girls. In: EIBEN, O. G. (ed.): Growth and Development. Physique. Symp. Biol. Hung. *20*, 177-189. - Akadémiai Kiadó, Budapest.

BODZSÁR, É. B. (1982): Growth and maturation. - Humanbiologia Budapestinensis *12*, 199-205.

BODZSÁR, É. B. (1991): The Bakony Growth Study. - Humanbiologia Budapestinensis *22*.

DANKER, H. and BENTZ, I. (1982): Relationships between menarcheal age and some body measurements. - Humanbiologia Budapestinensis *12*, 221-235.

FARKAS, Gy. and SZEKERES, E. (1982): On the puberty of girls in Szeged, Hungary. - Acta Biol. Szeged. *28*, 147-155.

FRISCH, R. E. and REVELLE, R. (1970): Height and weight at menarche and a hypothesis of critical body weight and adolescent events. - Science *169*, 397.

HAJTMAN, B. (1968): Bevezetés a matematikai statisztikába pszichológusok számára. - Akadémiai Kiadó, Budapest.

MARTIN, R. and SALLER, K. (1966): Lehrbuch der Anthropologie. 3. - Fischer Verlag, Stuttgart.

PÁPAI, J. (1996): Sexual maturation and growth in the Jászság children. In: BODZSÁR, É.B. and SUSANNE, C. (eds): Studies in Human Biology. - Eötvös Univ. Press, Budapest, 221-230 pp.

TANNER, J.M. (1961): Education and physical growth. - University of London, London.

WEINER, J.E. and LOURIE, J. A. (1969): Human Biology. A Guide to Field Methods. - IBP Handbook No. *9*, Blackwell, Oxford.

ACTA BIOL. SZEGED. 42, pp. 183-188 (1997)

LATERALITY OF CHILDREN WITH LEARNING DISABILITY

J. BUDAY and I. KAPOSI

Bárczi Gusztáv Training College Teachersa of Handicapped, Department of Pathophysiology, H-1071, Budapest, Bethlen tér 2, Hungary
Institute of Isotopes, H-1071, Budapest, Bethlen tér 2, Hungary

(Received: December 16, 1996)

Abstract

There is an empirical connection between the left-handed or not consistent hand dominance and a learning disability (FROSTIG, 1983). The left- or not consistent dominance may cause uncertain space orientation (NAGAE, 1985; LAENG and PETERS, 1995; BISIACH, 1996), and may therefore exert an undirected influence on learning. This study forms part of a larger project, sponsored by the SOROS Foundation, No. 065/0191.

Key words: laterality, learning disability.

Introduction

Laterality, i.e. the side dominance in the human race, is a long-known and well-studied human feature. Most people are right-handed and also prefer the right leg and eye. The association of handedness and lateral dominance concerning the language was first described by BROCA in 1865. The right side is under the control of the left hemisphere, but the handedness is influenced by the hemisphere dominance.

The connection between handedness and speech was also recognised by Broca (1865). The first observation of the association between lateral dominance and dyslexia was reported by ORTON (1937). The motor speech center in the frontal lobe (Br. 45) and also the sensorial center of the speech (WERNICKE's area, Br 41) are in the left hemisphere of the brain in right-handers and some left-handers. This old observation was supported by MRI findings (MOUNDAS et al., 1995). The asymmetry of the cortex was also revealed in the cerebellum by MRI (SYNDER et al., 1996).

According to another early observation, a number of stutterers and also their relatives are left-handers (SZONDI, 1937). Children with dyslexia or the partial lack of some other ability are often left-handers (BRUNSWICK and RIPPON, 1994; HISCOCK and KISBOURNE, 1995; RICCIO and HYND, 1996). There is an empirical connection between laterality and speech disorders or the late development of speech. There is also a connection between laterality and anxiety (DEJONG et al., 1995; NAVETEUR and

HONORÉ, 1995), and between laterality and the predisposition to psychosis (RICHARDSON, 1994). Left- and mixed-handedness are significantly frequent among autistic children (STATZ, 1985) and mentally retarded children (BATHEJA and MCMANUS, 1986).

The different intelligence structures of left- and right-handers have been described. ÁRGYÁN and JAKAB (1956) did not find a significant difference in the intelligence age, although the left-handers' performance intelligence was higher. In contrast MASCIE-TAYLOR (1980) found a higher verbal IQ among left-handers. The performance IQ was greater among right- and mixed-handers. If left-handedness is hereditary, the cognitive functions are better than if there are no other left-handers in the family (VAN STRIEN and BOUMS, 1995).

Despite these studies on the laterality of children and also the abundant experience reported on the lack of special ability among left- or mixed-handers, only a few systematic investigations have been made on the laterality of children with a learning disability.

Subjects and method

This study forms part of a larger project. The project concerns visual acuity, including colour vision, hearing performance and laterality among children with a partial ability lack, such as learning disabilities or dyslexia, who are educated in a special school.

The total number of examined children was 347: 214 boys and 133 girls, aged from 6 to 15 years.

There are numerous different methods for the determination of handedness. The most frequent are based on questionnaires, which are sometimes difficult to use for children. The most detailed method for examination of the laterality of the hand, foot and eye was published by HARRIS (1974). This was modified by VAYER (1974) and later by CAPELLINI and HAUSER (1991). The modified method has been used in our work for two reasons: the intelligence level of the children involved in the study is such that they do not understand some of the original points in the test, and some of them cannot yet write.

In this method, the handedness is examined from 10 different aspects. We speak about strong right- or left-handers if the child performs more than 8 tasks with the given hand. For moderate right- or left-handers, the given hand is used 8 or 7 times. The mixed-handed children perform 6 or 5 tasks with the given hand.

Tests of preference involving the leg and also the eye contain 3 tasks. Right- or left-footed and right- or left-eyed children perform at least 2 tasks in the test with the given leg and eye.

Results

Most studies of laterality deal with handedness. The variations of handedness among adults may result from influences of genetic and cultural factors (LALAND et al., 1995), though inherited factors seem more important (AKINORI and MASAOMI, 1985). The environmental influences include the intrauterine period (SCHLEIRS and VINGERHOCK, 1995) and possibly birth problems, though later observations did not confirm this. The age of a child is not connected with handedness, but before school age the distribution of laterality is "natural". Subsequently the training in the school prefers the right hand, and therefore the distribution changes (KOVAC, 1995). Handedness is also important in the development of children's drawing (GLENN et al ., 1995).

In our subjects, there was no significant difference between the boys and the girls, and no connection was found between handedness and the age of the child. About three-quarters of the pupils are right-handers (Table 1). The number of left-handers is greater among the boys in our material. The proportion of strong right- and left-handers (i.e. the consistent handers) are also greater among the boys than the girls.

This finding conforms to the GESCHWIND-BEHAN-GALABURDA model (GESCHWIND and BEHAN, 1982; GESCHWIND and GALABURDA, 1985a, b, c). In the early period of ontogenesis of the boys, the number of corpus callosum fibers is low because of the high testosterone level. Therefore, consistent laterality is frequent among boys. There is no similar influence in girls, so incomplete handedness is almost twice as frequent among them as among boys (the gray rows in Table 1). There are some opposite observations: a post mortem examination revealed that the callosal surface was 11% greater among left- and mixed-handers (WITELSON, 1985).

Table 1. Handedness.

Sexes	Strong left-handers		Moderate left-handers		Mixed-handers		Moderate right-handers		Srong right-handers		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Boys	16	7.5	8	3.7	8	3.7	17	7.9	165	77.2	214	100.0
Girls	7	5.3	8	6.0	8	6.0	9	6.8	101	75.9	133	100.0
Total	23	6.6	16	4.6	16	4.6	26	7.5	266	76.7	347	100.0

The preference of the leg has not been widely reported in the literature. There is no significant difference between right- and left-handed children as concerns the preferred leg. The proportion of right-legged children increases with age up to 11 years (GENTRY and GABBARD, 1995). Adults more often prefer the right leg because of environmental influences, e. g. car driving prefers the right leg (GABBARD and HART ,1996).

Table 2. Preference of the leg.

Sexes	Left		Right		Total	
	n	%	n	%	n	%
Boys	35	16.4	179	83.6	214	100.0
Girls	22	16.5	111	83.5	133	100.0
Sum	57	16.4	290	83.6	347	100.0

Similar proportions were observed as concerns the preferred legs among boys and girls (Table 2). More than four-fifths of the children prefer the right leg. No connection was found between the age and the preferred leg, perhaps because the method used is not sensitive enough.

A strong connection has been described between the preferred eye and the dominance of the motor functions (PREVIC, 1994) and also the motor memory (ENRIGHT, 1995). In our material, the preference of the left eye is more frequent than that of the hand or the leg. Two-fifths of the pupils preferred the left eye (Table 3).

Table 3. Preference of the eye.

Sexes	Left		Right		Total	
	n	%	n	%	n	%
Boys	85	39.7	129	61.3	214	100.0
Girls	56	42.1	77	57.9	133	100.0
Total	141	40.5	203	58.5	347	100.0

As regards the combinations of preferred hand, leg and eye, there is a general tendency for a consistent dominance when the preferred hand, leg and eye are on the same side, but any other patterns are also possible. Almost all right-handed persons preferred their right leg, and half of the left-handers are also right-legged. There is no significant difference in the preferred eye between the right- and left-handers (GABBARD and HURT, 1995). It was not confirmed that crossed dominance of the hand, leg and eye is connected with low intelligence (SULBACHER et al., 1994).

A consistent dominance was found in about half of our pupils (Table 4). The next most frequent combination is the opposite side (the gray in Table 4): when the preferred hand and the preferred eye are not on the same side. This situation is more frequent among the girls than the boys: 43.6% and 38.8%, respectively.

Table 4. Combination of the preferences of hand, leg and eye.

Combinations			Boys		Girls	
Hand	Leg	Eye	n	%	n	%
Right	Right	Right	106	49.6	61	45.7
Left	Left	Left	8	3.7	3	2.3
Right	Right	Left	62	29.0	41	30.8
Left	Left	Right	5	2.3	3	2.3
Right	Left	Left	10	4.7	7	5.3
Left	Right	Right	6	2.8	5	3.8
Right	Left	Right	12	5.6	9	6.8
Left	Right	Left	5	2.3	4	3.0
	Total		214	100.0	133	100.0

Table 5. Correlations.

	Hand	Leg	Eye	
Hand	1.000	0.563	0.140	Girls
Leg	0.557	1.000	0.191	
Eye	0.163	0.132	1.000	
		Boys		

A significantly high correlation was found between the boys' preferred hand and leg, and hand and eye (left matrix in Table 5), but there was no correlation between the leg and eye. There was a high correlation only between the hand and the eye of the girls (right matrix in Table 5), but no correlation between the hand and the eye, or the leg and the eye. Among the boys, therefore the preferences of the leg and the eye are independent from each other, but both depend on the preference of the hand. Among the girls, the preference of the hand depends on the leg, but both are independent of the preference of the eye.

References

AKINORI, S. and MASAOMI, E. (1985): Handedness Conversion in Children and Parental Handedness. - Folia Psychiatria et Neurologica Japonica *39*, 19-23.

ÁRGYÁN, A. and JAKAB, I. (1956): A feltételes reflexek és az intelligencia összehasonlító vizsgálata balkezes gyermekeken az írás-olvasás tanulásának korában. - Ideggyógyászati Szemle *9*, 116-122.

BATHEJA, M. and MCMANUS, J. C. (1985): Handedness in the mentally handicapped. - Developmental Medicine and Child Neurology *27*, 63-68.

BISIACH, E. (1996): Unilateral neglect and the srtucture of space representation. -Current Directions in Psychological Science *5*, 62-65.

BRUNSWICK, N. and RIPPON, G. (1994): Auditory event-related potentials, dichotic listening performance and handedness as indices of lateralization in dyslexic and normal readers. - Internat. J. Psychophysiol. *18*, 265-275.

CAPELLINI, A. C. and HAUSER, G. (1992): Seitenpräferenzen italianischer Schulkinder. In: Anthropologie - Wissenschaft vom Menschen für den Menschen. - Wiss. Zeitschrift der Humboldt-Universität zu Berlin, R. Medizin. Teil II. 197-200.

DEJONG, J., MERCKELBACH, H. and NIJMAN, H. (1995): Hemisphere preference, anxiety and covariation bias. - Personality and Individual Differences *18*, 363-371.

ENRIGHT, J. T. (1995): The non-visual impact of eye orientation on eye-hand coordination. - Vision Research *35*, 1611-1618.

FROSTIG, M. (1983): Bewegungs-Erziehung. Neue Wege der Heilpadagogik. - Ernst Reihardt Verlag, München.

GABBARD, C. and HURT, S. (1995): Foot performance of right- and left-handers: A question of environmental influence. - Perceptual and Motor Skills *80*, 671-674.

GENTRY, V. and GABBARD, C. (1995): Foot-preference behavior: A developmental perspective . - J. Gen. Psychol. *122*, 37-45.

GESCHWIND, N. and BEHAN, P. (1982): Left-handedness: association with immune disease, migraine, and developmental learning disorder. - Proceedings of the National Academy of Sciences (USA) 79, 5097-5100.

GESCHWIND, N. and GALABURDA, A. M. (1985a): Cerebral lateralization: Biological mechanisms, associations, and pathology: I. A hypothesis and program for research. - Archives of Neurology *42*, 428-459.

GESCHWIND, N. and GALABURDA, A. M. (1985b): Cerebral lateralization: Biological mechanisms, associations, and pathology: II. A hypothesis and program for research. - Archives of Neurology *42*, 521-522.

GESCHWIND, N. and GALABURDA, A. M. (1985c): Cerebral lateralization: Biological mechanisms, associations, and pathology: III. A hypothesis and program for research. - Archives of Neurology *42*, 634-654.

GLENN, S. M., BRADSHAW, K. and SHARP, M. (1995): Handedness and the development of direction and sequencing in children's drawing od people. - Educational Psychology *15*, 11-21.

HARRIS, J. (1974): HARRIS test of Lateral Dominance. - The Psychological Corporation, New York (3rd ed).

HISCOCK, M. and KINSBOURNE, M. (1995): Progress in the measurement of laterality and implications for dyslexia research. - Annals of Dyslexia *45*, 249-268.

HYND, G. W., HALL, J., NOVEY, E. S. and ELIOPULOS, D. (1995): Dyslexia and corpus callosum morphology. - Archives of Neurology *52*, 32-38.

KOVAC, D. (1995): Pair interaction: Handedness development. - Studia Psychologia *37*, 89-92.

LAENG, B. and PETERS, M. (1995): Cerebral lateralization for the processing of spatial coordinates and categories in left- and right-handers. - Neuropsychology *33*, 421-439.

LALAND, K. N., VAN HORN, J. D. and FELDMAN, M. V. (1995): A gene culture model of human handedness. - Behaviour Genetics *25*, 432-445.

MASCIE-TAYLOR, C. N. G. (1980): Hand preference and Components of I.Q. - Annals of Human Biology *7*, 235-248.

NAGAE, S. (1985): Handedness and sex differences in selective interference of verbal and spatial information. - J. Experimental Psychol. Human Perception and Performance *11*, 346-354.

ORTON, S. (1937): Reading, writing and speech problems in children. - Chapman and Hall, London.

PREVIC, F. H. (1994): The relationship between eye dominance and head tilt in humans. - Neuropsychologia *32*, 1297-1303.

RICHARDSON, A. J. (1994): Dyslexia and syndromes of psychosis-pronenesses. - Int. J. Psyhophysiol. *28*, 215-263.

RICCIO, C. A. and HYND, G. W. (1996): Neuroanatomical and neuropsychological aspects of dyslexia. - Language Disorders *16*, 1-13.
SULBACHER, S., THOMSON, J., FARWELL, J. R. and TEMKIN, N. R. (1994): Crossed dominance and its relationship to intelligence and academic achievement. - Develop. Neuropsychol. *10*, 473-479.
STATZ, P. (1985): Handedness subtypes in autism. - Psychiatric Annals *15*, 447-450.
SZONDI, L. (1937): Contribution to fate analysis I. Analysis of marriages. - Acta Psychologica (Amsterdam) *3*, 1-80.
SYNDER, P. J., BILDER, R. M. and WU, H. B. (1995): Cerebellar volume asymmetries are related to handedness: A quantitative MRI study. - Neoropsychol. *33*, 407-419.
VAN STRIEN, J. W. and BOUMS, A. (1995): Sex and familial simistrality differences in cognitive abilities. - Brain and Cognition *27*, 137-146.
VAYER, P. (1974): Educazione psicomotoria nell' eta scolastica. - Edit. Armendo, Roma.
WITELSON, S. F. (1985): The brain connection: The corpus callosum is larger in left-handers. - Science *229*, 665-668.

ACTA BIOL. SZEGED. 42, pp. 189-199 (1997)

IMMUNOHISTOCHEMICAL LOCALIZATION OF THE ACETYLCHOLINE RECEPTOR IN THE MAMMALIAN NEUROMUSCULAR JUNCTION

A. E. CSILLIK

Department of Clinical Neurology, Albert Szent-Györgyi Medical University H-6701 Szeged, Semmelweis u. 6., Hungary

(Received: December 10, 1996)

Abstract

Through the use of biotinylated α- bungarotoxin, the nicotinic acetylcholine receptor has been localized in mammalian motor end plates at light and electron microscopic levels. The receptor is located in the primary post-synaptic membrane of the neuromuscular junction. Neither the presynaptic membrane nor the secondary postsynaptic membrane, which is thrown into junctional folds, contains any traces of the nicotinic acetylcholine receptors. This localization is at variance with that of acetylcholinesterase, which is present in both primary and secondary postsynaptic and the presynaptic membranes. Consequently, subneural apparatuses visualized by α-bungarotoxin differ in fine details from those seen in acetylcholinesterase-stained specimens at both light and electron microscopic levels. Accordingly, theories suggesting the identity of acetylcholinesterase with the acetylcholine receptor cannot be sustained.

Key words: Acetylcholine receptor, nicotinic, neuromuscular junction, α-bungarotoxin, acetylcholinesterase, immunocytochemistry, electron microscopy

Introduction

Ever since LANGLEY's (1907) revolutionary hypothesis that a chemical substance mediates transmission of nerve impulses to the striated muscle, the acetylcholine receptor has played a central role in theories of chemical transmission. Recent molecular biological studies revealed that the nicotinic acetylcholine receptor, displaying a pentameral $2\alpha+\beta+\gamma+\delta$ structure (Fig. 1) which, as an allosteric protein (CHANGEUX, 1990), changes its shape after binding acetylcholine, has a funnel-like structure, the central channel of which the subserves the outward and inward motion of various cations (CHANGEUX et al., 1987).

The superfamily of ligand-gated ion channel neurotransmitter receptors includes GABA and glycine receptors in addition to the acetylcholine receptor (BARNARD, 1992). It is characteristic of this superfamily that the receptor is composed of five homologous subunits arranged around the central ion channel (UNWIN, 1993). Acetylcholine binding sites are located at specific subunit interfaces (SARGENT, 1993).

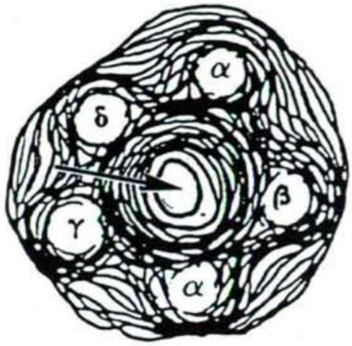

Fig. 1. Molecular structure of the nicotinic acetylcholine receptor. In a virtual cross-section, the central ion channel (arrow) is surrounded by five subunits (Greek letters) of the receptor. Adapted with permission from UNWIN (1989).

Immunohistochemical visualization of the acetylcholine receptor is a puzzling problem, partly because of the multitude of subunits which exhibit different immunogeneities, and partly because the century-old observation of denervation supersensitivity has been traditionally ascribed to the spread of acetylcholine receptors on the surface of the postsynaptic cell. With this dual aspect of the relevant problematics in mind, an attempt has been made to locate the nicotinic acetylcholine receptor in mammalian striated muscle, through the use of biotinylated α-bungarotoxin, at both light and the electron microscopic levels. The results of studies aiming to localize the acetylcholine receptor in denervated motor end plates will be published later.

Material and Methods

Investigations were performed on 22 young adult rats (200-250 g body weight) and on tissues from 2 young Macaca fascicularis monkeys, obtained by courtesy of the Section of Neurobiology, Yale University Medical School, New Haven, CT, USA. Care of the animals complied with the Albert Szent-Györgyi Medical University "Guidelines for Ethics in Animal Experiments". Animals in deep anesthesia were subjected to transcardial perfusion fixation with ZAMBONI's picric acid-formaldehyde solution containing 0.1% glutaraldehyde; this was preceded by a brief flush of 125 ml 0.1 M phosphate buffered saline, pH=7.4, at room temperature. After perfusion, the flexor digitorum brevis muscle was excised and post-fixed in glutaraldehyde-free ZAMBONI's solution for 24 hours. For light microscopic purposes, 30 µm thick frozen sections were obtained on a cryostat; for electron microscopic purposes, 50 µm thick vibratome sections were prepared. Both frozen and vibratome sections were incubated according to the free-floating technique, with biotinylated α-bungarotoxin (Molecular Probes, Inc., USA) as primary serum, which reacts with the α subunit of the nicotinic acetylcholine receptor (SCHOEPFER et al., 1990; CLARKE, 1992).

Further procedures of the immunohistochemical reaction were performed either according to the PAP method, or by the avidin-biotin technique, with the ABC kit of Vector Laboratories. The specificity of the antiserum was ascertained by incubation of control sections in antiserum-free normal goat serum or by omitting one of the components of the ABC kit. In none of the control experiments was any reaction encountered.

Incubation of the free-floating Vibratome or cryostat sections was carried out under constant movement in glass vials, either in a Pelco rotator or on a horizontal shaker.The immunohistochemical reaction was visualized with diaminobenzidine (DAB) + hydrogen peroxide, or with the nickel-DAB technique. Dehydration of the sections in an ascending series of alcohols and processing in xylenes was performed on sections dried to gelatine - coated ("subbed") slides. Sections were coverslipped with Permount.

Vibratome sections subjected to the immunohistochemical reaction were used for electron microscopic purposes as follows: after osmication and dehydration, sections were applied to slides pretreated with Liquid Release and flat-embedded in Araldite ACM. Relevant parts of the sections were excised under the light microscope and applied to prepolymerized Epon blocks. Ultrathin sections, 30 nm thick, were obtained on an LKB ultrotome using diamond knifes, stained with uranyl acetate and lead citrate and studied on a JEOL JEM 1010 transmission electron microscope.

Acetylcholinesterase was visualized at the light microscopic level, by means of GEREBTZOFF'S (1959) modification of the KOELLE (1950) acetylthiocholine iodide method, employing ethopropazine inhibition (10-6 to 10-8 M) in order to inactivate non-specific esterases and butyryl(pseudo)cholinesterase. Electron microscopic demonstration of acetylcholinesterase was performed by the copper-uranyl-thiocholine method described by CSILLIK and KNYIHÁR (1968).

Results

Under the light microscope, biotinylated α-bungarotoxin visualizes structures identical with COUTEAUX's (1947, 1955) subneural apparatus (Fig. 2). In this respect, there was no difference between rat and monkey muscles; however, the latter were conspicuously larger than the former, most probably because of the differences in the sizes of the related striated muscle fibers innervated by the neuromuscular junctions. However, in contrast with the patterns obtained with acetylcholinesterase staining techniques (CSILLIK, 1967), which are invariably characterized by the spiny appearance of the borderlines of the acetylcholinesterase-positive gutters (Fig. 6a), the outlines of the subneural apparatuses visualized with α-bungarotoxin (Fig. 4) are completely smooth. In other words, COUTEAUX's "organites", which have been shown (CSILLIK et al., 1966) to be light microscopic equivalents of the junctional folds, failed to contain the nicotinic acetylcholine receptor. In cross-sections, especially in the large motor end plates of primates (Fig 3), the acetylcholine receptor outlines the gutter underlying the motor nerve terminal.

At the level of electron microscopy, α-bungarotoxin outlined the primary postsynaptic membrane of the neuromuscular junction (Fig. 5). Earlier studies (CSILLIK, 1993) revealed that the primary postsynaptic membrane is identical with the crests of the junctional folds. In contrast, the secondary postsynaptic membrane, i.e. the junctional folds themselves, does not contain any acetylcholine receptor. The transition between the intensely reacting primary postsynaptic membrane and the immunoreaction-free secondary postsynaptic membrane is clearly demarcated. Neither did the presynaptic membrane exert any acetylcholine receptor immunoreactivity.

In light microscopic specimens, the acetylcholinesterase reaction outlines the organites of subneural apparatuses (Fig. 6a). Accordingly, neuromuscular junctions "stained" by the acetylcholinesterase technique exhibit a "spiny" or "thorny" appearance, which differs markedly from the smooth outlines of those "stained" for the acetylcholine receptor. At the level of electron microscopy (Fig. 6b), the end-product of the acetylcholinesterase reaction outlines both the pre- and the postsynaptic membranes, including the entire extents of the junctional folds.

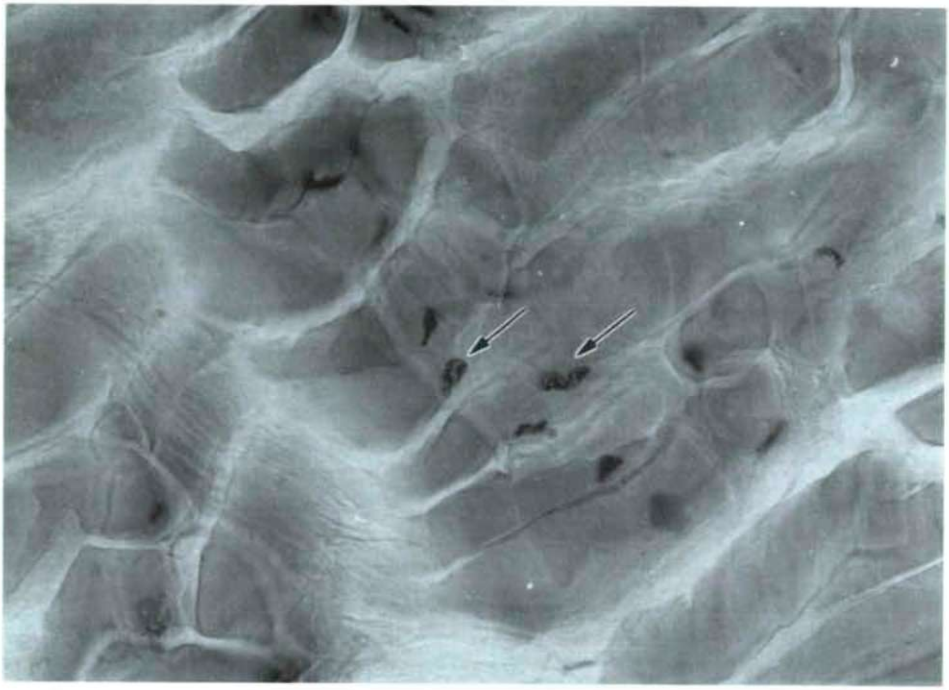

Fig. 2. Localization of the nicotinic acetylcholine receptor in the flexor digitorum brevis muscle of the rat. Arrows indicate some of the motor end plates displaying acetylcholine receptor immunoreactivity. × 100.

Discussion

Structural analysis of cholinergic impulse transmission was initiated by the histochemical demonstration of the enzyme hydrolyzing acetylcholine, i.e. acetylcholinesterase (KOELLE and FRIENDENWALD, 1949; KOELLE, 1950). Due to its evasively small size and diffusibility, the transmitter itself could not be detected with histochemical techniques (CSILLIK, 1975), except for the indirect evidence provided by the radioautographic localization of hemicholinium (CSILLIK et al., 1970; KNYIHÁR and CSILLIK, 1970). Before the advent of immunohistochemical techniques, localization of the enzyme synthesizing acetylcholine, i.e. choline acetyltransferase, and that of the protein binding acetylcholine, i.e. the acetylcholine receptor, were tantalizing questions of neurohistochemistry. Whereas the localization of choline acetyltransferase, at both light and electron microscopic levels, could be achieved flawlessly by using mono- and polyclonal immune sera directed against this enzyme protein (LEVEY et al., 1982; MESULAM et al., 1983), the fine structural identification of the nicotinic acetylcholine receptor remained a partially unaccomplished problem.

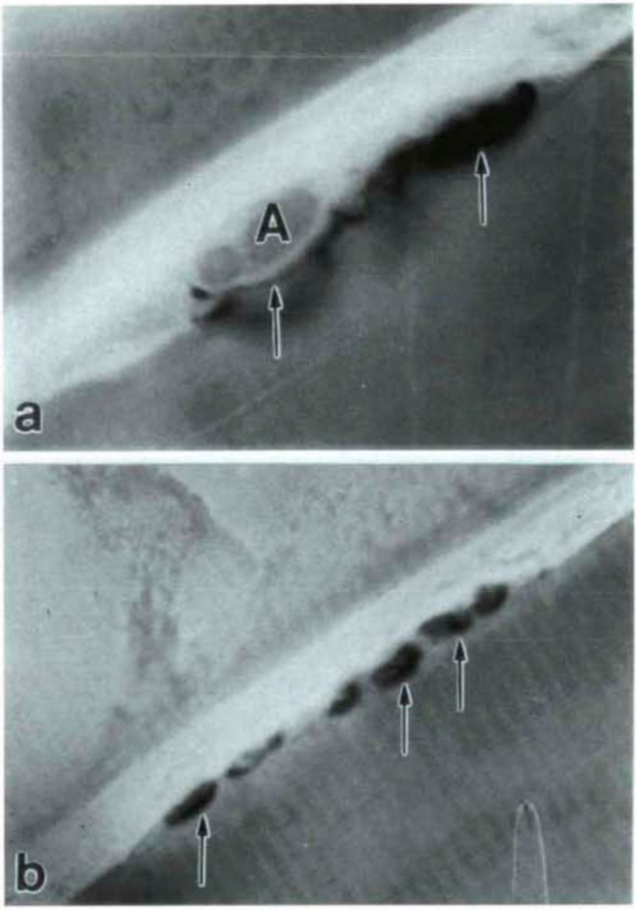

Fig. 3. Cross-sections of the subneural apparatus in the monkey flexor digitorum muscle. Note that the barely visible axon terminals (A) do not exert any acetylcholine receptor immunoreactivity, whereas the postsynaptic membranes which appear as cross-sections of gutters (arrows) contain high amounts of the acetylcholine receptor. × 2500

It is known that α-bungarotoxin blocks neurotransmission at the neuromuscular junction in a "remarkably potent, specific and persistent manner" (CLARKE, 1992). Binding of α-bungarotoxin to the α subunit of the nicotinic acetylcholine receptor in the neuromuscular junction (and to α7 in the central nervous system) is well established (SCHOEPFER et al., 1990; CLARKE, 1992; SARGENT, 1993). According to LEE, who first purified α-bungarotoxin from elapid snake venom (CHANG and LEE, 1963) and later characterized it (LEE et al., 1967; LEE, 1972), the toxin has a high affinity and specificity for the acetylcholine receptor in skeletal muscle. Binding of α-bungarotoxin to the acetylcholine receptor is virtually irreversible (MILEDI and POTTER, 1971).

Fig. 4. Localization of the nicotinic acetylcholine receptor in neuromuscular junctions of the flexor digitorum brevis muscle of the rat (arrows). Note the smooth outlines of the subneural apparatuses which display receptor immunoreactivity. Arrowhead in 4c indicates cross-section of a subneural apparatus. Note absence of any reaction of the organites, especially conspicuous in 4d, which depicts a subneural apparatus exerting modest acetylcholine receptor immunoreactivity. × 1000

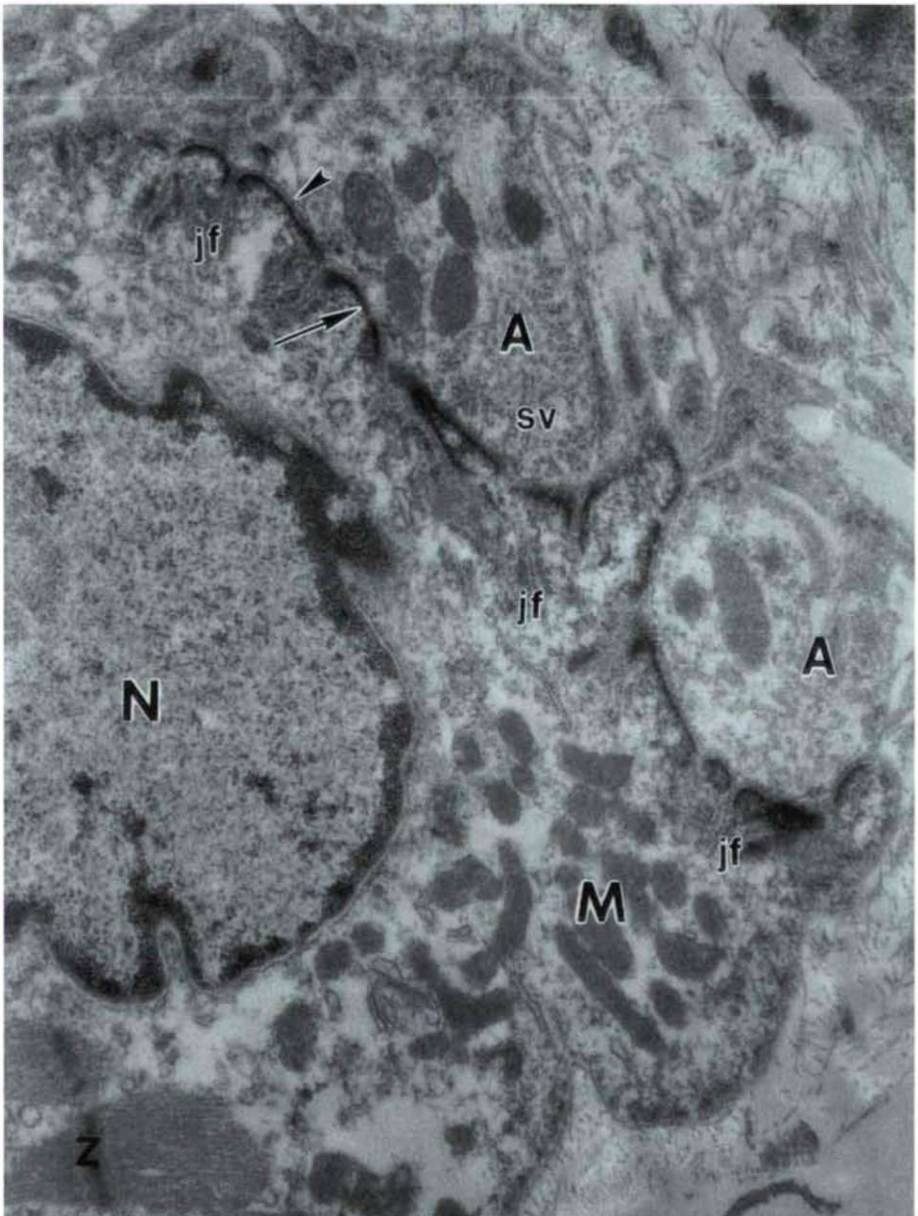

Fig. 5. Localization of the acetylcholine receptor at the electron microscopic level. Flexor digitorum brevis muscle of Macaca fascicularis. Note immunoreactivity of the primary postsynaptic membrane (arrows). Neither the presynaptic membrane (arrowhead) nor the secondary postsynaptic membrane, thrown into junctional folds (JF), exhibits any receptor immunoreactivity. A: cross-section of the axon terminal; sv: synaptic vesicles; N: fundamental nucleus; M: accumulation of siderophilic fundamental mitochondria; Z: Z-line of striated muscle fiber. × 25,000

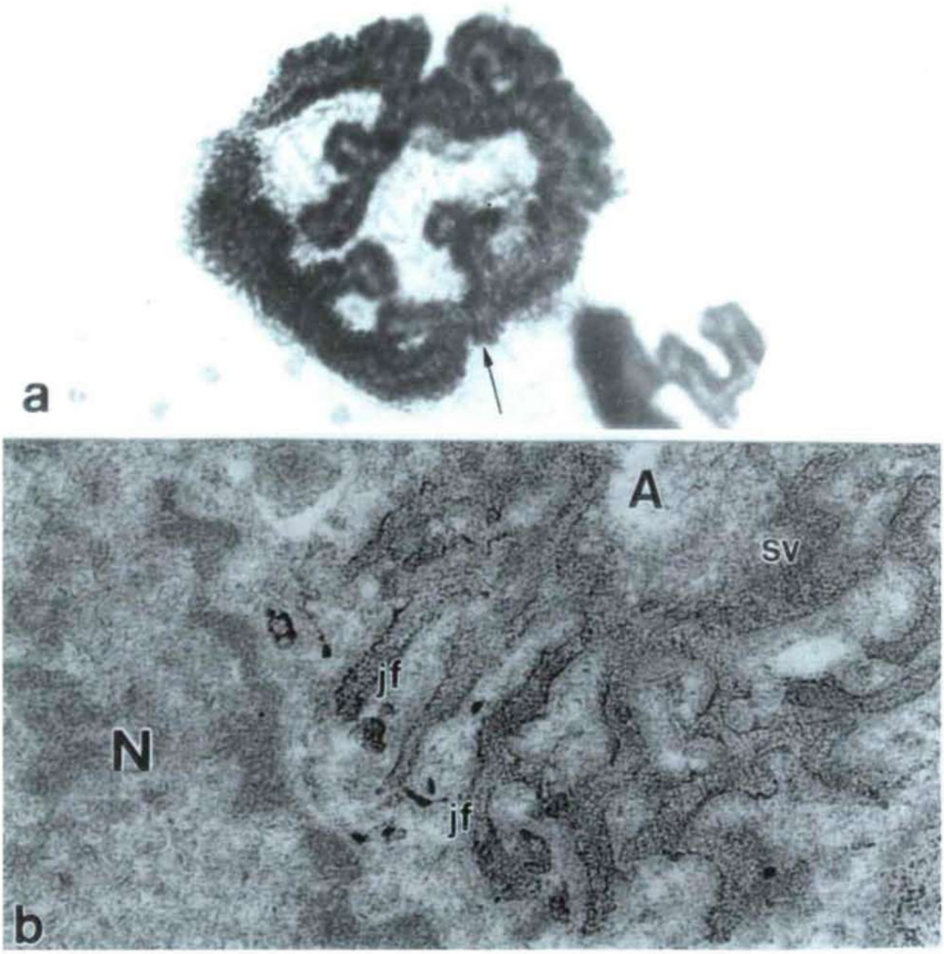

Fig. 6. Acetylcholinesterase activity of motor end plates in the rat gastrocnemius muscle. (a): Spiny appearence of the outlines (arrow)) of the acetylcholinesterase-active subneural apparatus; this is due to the acetylcholinesterase reaction of the organites (light microscopic equivalents of junctional folds). x 1000. (b): Electron microscopic localization of acetylcholinesterase activity in the neuromuscular junction. Note that both the pre- and postsynaptic membranes, including the secondary postsynaptic membrane of the junctional folds (jf), display acetylcholinesterase activity. The synaptic cleft contains traces of the end-product of the acetylcholinesterase reaction. A: cross-section of the terminal axon; sv: synaptic vesicles. N: fundamental nucleus. × 35,000

On the basis of this principle, localization of the nicotinic acetylcholine receptor has been attempted with radioautographic methods, by using 125I-labeled α-bungarotoxin at both light and electron microscopic levels (LEE et al., 1967; HARTZELL and FAMBROUGH, 1972; VOGEL et al., 1972; FISCHBACH and COHEN, 1973; PORTER et al., 1973; ALBUQUERQUE et al., 1974; FERTUCK and SALPETER, 1974; PORTER and BARNARD, 1975; FERTUCK and SALPETER, 1976). Conjugates of α-bungarotoxin with fluorescent dyes have also been used to locate the acetylcholine receptor of the neuromuscular junction (ANDERSON and COHEN, 1974). Ferritin-labeled α-bungarotoxin was used for electron microscopy (HOURANI et al., 1974) and horseradish peroxidase conjugates of α-bungarotoxin were employed at both light and electron microscopic levels (DANIELS and VOGEL, 1975; JENSEN et al., 1975; LENTZ et al., 1977). The use of biotinylated α-bungarotoxin (AXELROD, 1980) is a relatively novel approach for location of the nicotinic acetylcholine receptor at light and electron microscopic levels (MA et al., 1993; KNYIHÁR-CSILLIK et al., 1995; CSILLIK et al., 1995a, b; 1996).

The present studies indicated that neither the presynaptic nor the secondary postsynaptic membrane, i.e. the junctional folds themselves, contains any nicotinic acetylcholine receptor. In other words, the acetylcholine receptor in the neuromuscular junctions of adult mammals is confined to the the primary postsynaptic membrane. This localization is at striking variance with that of acetylcholinesterase, which is present in both pre- and postsynaptic membranes of the neuromuscular junction, including the depths of the junctional folds. In fact, such an organization is optimal for the role of the acetylcholine molecule in neuromuscular impulse transmission: once released from the axon terminal, it passes the synaptic gap and binds to the acetylcholine receptor in the postsynaptic membrane. Excess acetylcholine, not bound to the receptor, will be effectively hydrolyzed by the enzyme in the synaptic cleft, in the postsynaptic membrane and, if any transmitter occurs in excess amount, in the depths of the junctional folds.

Differential localization of the acetylcholine receptor and the enzyme acetylcholinesterase does not support the theories regarding the identity of this receptor and enzyme (ZUPANCIC, 1967; STALC and ZUPANCIC, 1972). A membrane mosaic consisting of acetylcholinesterase and the nicotinic acetylcholine receptor, as suggested by BARNARD et al., (1971), is plausible in the primary postsynaptic membrane; however, in the case of the junctional folds, i.e. in the secondary postsynaptic membrane, only acetylcholinesterase molecules are present, which excludes any membrane mosaic at this location.

Finally, the question of the presence of acetylcholinesterase and the absence of the nicotinic acetylcholine receptor in the presynaptic membrane (and in the synaptic cleft) should be addressed. The immunohistochemical technique employed here is apparently more specific than the horseradish-labeled compounds used by earlier investigators; LENTZ et al. (1977) for instance, also observed a "faint" reaction presynaptically. In all probability, this was a technical artifact, perhaps due to the substantivity of horseradish peroxidase. On the other hand, the presence of muscarinic acetylcholine receptors on the presynaptic membrane is a viable possibility, which has been suggested by recent pharmacological studies (VIZI and SOMOGYI, 1989).

Acknowledgement

These studies were supported by the National Scientific Research Fundation (OTKA Grants No. T-006357 and T-016046).

References

ALBUQUERQUE, E. X., BARNARD, E. A., PORTER, C. W. and WARNICK, J. E. (1974): The density of acetylcholine receptors and their sensitivity in the postsynaptic membrane of muscle endplates. - Proc. Natl. Acad. Sci. USA (Wash.) *71*, 2818-2822.

ANDERSON, M. J. and COHEN, M. W. (1974): Fluorescent staining of acetylcholine receptors in vertebrate skeletal muscle. - J. Physiol. (London) *237*, 385-400.

AXELROD, D. (1980): Crosslinking and visualization of acetylcholine receptors on myotubes with biotinylated alpha-bungarotoxin and fluorescent avidin. - Proc. Natl. Acad. Sci. USA (Wash.) *77*, 4823-4827.

BARNARD, E. A. (1992): Receptor classes and the neurotransmitter-gated ion channels. - Trends Biochem. Sci. *17*, 368-374.

BARNARD, E. A., WIECKOWSKI, J. and CHIU, T. H. (1971): Cholinergic receptor molecules and cholinesterase molecules at mouse skeletal muscle junctions. - Nature (London) *234*, 207-209.

CHANG, C. C. and LEE, C. Y. (1963): Isolation of neurotoxins from the venom of Bungarus multicinctus and their modes of neuromuscular blocking action. - Arch. Pharmacodyn. *144*, 241-257.

CHANGEUX, J. P. (1990): Functional architecture and dynamics of the nicotinic acetylcholine receptor: An allosteric ligand-gated ion channel. In: CHANGEAUX, J. P., LLINAS, R. R., PURVES, D. and BLOOM, F. E. (eds): Fidia Research Foundation Neuroscience Award Lectures. - Raven Press, New York *4*, 21-168.

CHANGEUX, J. P., GIRAUDAT, J. and DENNIS, M. (1987): The acetylcholine receptor: Molecular architecture of a ligand-gated ion channel. - Trends Pharmacol. Sci. *8*, 459-465.

CLARKE, P. B. S. (1992): The fall and rise of neuronal α-bungarotoxin binding proteins. - Trends Pharmacol. Sci. *13*, 407-413.

COUTEAUX, R. (1947): Contribution a l'etude de la synapse myoneurale. - Rev. canad. Biol. *6*, 563-711.

COUTEAUX, R. (1955): Localisation of cholinesterases at neuromuscular junctions. - Int. Rev. Cytol. *4*, 335-376.

CSILLIK, B (1967): Functional structure of the post-synaptic membrane in the myoneural junction. 2nd ed. - Akadémiai Kiadó, Budapest.

CSILLIK, B. (1975): Synaptochemistry of acetylcholine metabolism in a cholinergic neuron. - Internat. Review of Neurobiology *18*, 69-140.

CSILLIK, B. (1993): Calcium channels in the neuromuscular junction. - Internat. Review of Cytology *147*, 193-232.

CSILLIK, B., HAARSTAD, V. B. and KNYIHÁR, E. (1970): Autoradiographic localization of 14C hemicholinium: an approach to locate sites of acetylcholine synthesis. - J. Histochem. Cytochem. *18*, 58-60.

CSILLIK, B., JOÓ, F., KÁSA, P. and SÁVAY, G. (1966): Pb-thiocholine techniques for the electron histochemical localization of acetylcholinesterase. - Acta Histochem. *25*, 58-70.

CSILLIK, B. and KNYIHÁR, E. (1968): On the effect of motor nerve degeneration on the fine-structural localization of esterases in the mammalian motor end plate. - J. Cell Sci. *3*, 529-538.

CSILLIK, B., RAKIC, P., GOLDMAN-RAKIC, P. S. and KNYIHÁR-CSILLIK, E. (1995a): Topographical correlations between CGRP and the nicotinic acetylcholine receptor in Meynert's basal nucleus and in the prefrontal cortex of the primate brain. - Neurobiology *3*, 36-37.

CSILLIK, B., RAKIC, P., GOLDMAN-RAKIC, P. S., CHASE, B., NEMCSÓK, J. and KNYIHÁR-CSILLIK, E. (1995b): Topographical correlations between CGRP and the nicotinic acetylcholine receptor in the neuromuscular junction, in Meynert's basal nucleus and in the prefrontal cortex. - Acta Anat. *152*, 272.

CSILLIK, B., RAKIC, P. and KNYIHÁR-CSILLIK, E. (1996): Neuropeptidergic innervation of Meynert's basal nucleus in primates: functional and pathological implications. - Neurobiology *4*, 137.

DANIELS, M. P. and VOGEL, Z. (1975): Immunoperoxidase staining of α-bungarotoxin binding sites in muscle endplates shows distribution of acetylcholine receptors. - Nature (Lond.) *254*, 339-341.

FERTUCK, H. C. and SALPETER, M. M. (1974): Localization of acetylcholine receptor by 125I-labeled α-bungarotoxin binding at mouse motor endplates. - Proc. Natl. Acad. Sci., USA (Wash.) *71*, 1376-1378.

FERTUCK, H. C. and SALPETER, M. M. (1976): Quantitation of junctional and extrajunctional acetylcholine receptors by electron microscope autoradiography after α-bungarotoxin binding at mouse neuromuscular junctions. - J. Cell Biol. *69*, 144-158.

FISCHBACH, G. D. and COHEN, S. A. (1973): The distribution of acetylcholine sensitivity over uninnervated and innervated muscle fibers grown in cell culture. - Develop. Biol. *31*, 147-162.

GEREBTZOFF, M. A. (1959): Cholinesterases. - Pergamon Press, London-Oxford-New York-Paris.

HARTZELL, H. C. and FAMBROUGH, D. M. (1972): Acetylcholine receptors: distribution and extrajunctional density in rat diaphragm after denervation correlated with acetylcholine sensitivity. - J. Gen. Physiol. *60*, 248-262.

HOURANI, B. T., TORAIN, B. F., HENKART, M. P., CARTER, R. L., MARCHESI, V. T. and FISCHBACH, G. D. (1974): Acetylcholine receptors of cultured muscle cells demonstrated with ferritin-α-bungarotoxin conjugates. - J. Cell Sci. *16*, 473-479.

JENSEN, C., LUTIN, W., FREEMAN, J. and BRADY, R. (1975): Localization of ACh receptor (AChR) in brain using horseradish peroxidase-conjugated snake neurotoxin. - J. Cell Biol. *67*, 191A.

KNYIHÁR, E. and CSILLIK, B. (1970): Localization of inhibitors of the acetylcholine- and GABA-synthesizing systems in the rat brain. - Exp. Brain Res. *11*, 1-16.

KNYIHÁR-CSILLIK E., MOHTASHAM, S., NEMCSÓK, J., RAKIC, P., VÉCSEI, L. and CSILLIK, B. (1995): Relationship between CGRP and the acetylcholine receptor in the neuromuscular junction. - Neurobiology *3*, 82-83.

KOELLE, G. B. (1950): The histochemical differentiation of types of cholinesterases and their localizations in the tissues of the cat. - J. Pharmacol. Exp. Therap. *100*, 158-179.

KOELLE, G. B. and FRIENDENWALD, J. S. (1949): A histochemical method for localizing cholinesterase activity. - Proc. Soc. Exp. Biol. (N. Y.) *70*, 617-622.

LANGLEY, J. N. (1907): On the contraction of muscle, chiefly in relation to the presence of 'receptive' substances. - J. Physiol. (Lond.) *36*, 347-384.

LEE, C. Y. (1972): Chemistry and pharmacology of polypeptide toxins in snake venoms. - Ann. Rev. Pharmacol. *12*, 265-286.

LEE, C. Y., TSENG, L. F. and CHIU, T. H. (1967): Influence of denervation on localization of neurotoxins from elapid venoms in rat diaphragm. - Nature (Lond.) *215*, 1177-1178.

LENTZ, T. L., MAZURKIEWICZ, J. E. and ROSENTHAL, J. (1977): Cytochemical localization of acetylcholine receptors at the neuromuscular junction by means of horseradish peroxidase-labeled α-bungarotoxin. - Brain Res. *132*, 423-442.

LEVEY, A. I., RYE, D. and WAINER, B. H. (1982): Immunochemical studies of bovine and human choline-o-acetyltransferase using monclonal antibodies. - J. Neurochem. *39*, 1652-1659.

MA, J., NATSUK, M. A., MCKECHNIE, B. A. and FALLON, J. R. (1993): The agrin receptor: localization in the postsynaptic membrane, interaction with agrin, and relationship to the acetylcholine receptor. - J. Biol. Chem. *268*, 25108-25117.

MESULAM, M. M., MUFSON, E. J., LEVEY, A. I. and WAINER B. H. (1983): Cholinergic innervation of cortex by the basal forebrain: cytochemistry and cortical connections of the septal area, diagonal band nuclei, nucleus basalis (substantia innominata), and hypothalamus in the rhesus monkey. - J. Comp. Neurol. *214*, 170-197.

MILEDI, R. and POTTER, L. T. (1971): Acetylcholine receptors in muscle fibers. - Nature (Lond.) *233*, 599-603.

PORTER, C. W. and BARNARD, E. A. (1975): The density of cholinergic receptors at the endplate postsynaptic membrane: ultrastructural studies in two mammalian species. - J. Membrane Biol. *20*, 31-49.

PORTER, C. W., BARNARD, E. A. and CHIU, T. H. (1973): The ultrastructural localization and quantitation of cholinergic receptors at the mouse motor endplate. - J. Membrane Biol. *14*, 383-402.

SARGENT, P. B. (1993): The diversity of neuronal nicotinic acetylcholine receptors. - Annual Review of Neuroscience *16*, 403-443.

SCHOEPFER, R., CONROY, W. G., WHITING, P., GORE, M. and LINDSTROM, J. (1990): Brain α-bungarotoxin binding protein cDNAs and MAbs reveal subtypes of this branch of the ligand-gated ion channel gene superfamily. - Neuron *5*, 35-48.

STALC, A. and ZUPANCIC, A. O. (1972): Effects of α-bungarotoxin on acetylcholinesterase bound to mouse diaphragm endplates. - Nature New Biol. (London) *239*, 91-92.

UNWIN, N. (1989): The structure of ion channels in membranes of excitable cells. - Neuron *3*, 336-376.

UNWIN, N. (1993): Neurotransmitter action: opening of ligand-gated ion channels. - Cell *10*, 31-41.

VIZI, E. S. and SOMOGYI, G. T. (1989): Prejunctional modulation of acetylcholine release from skeletal neuromuscular junction: link between positive (nicotinic) and negative (muscarinic) feedback modulation. - Brit. J. Pharmacol. *97*, 65-70.

VOGEL, Z., SYTKOWKSI, A. J. and NIRENBERG, M. W. (1972): Acetylcholine receptors of muscle grown in vitro. - Proc. Natl. Acad. Sci. USA (Wash.) *69*, 3180-3184.

ZUPANCIC, A. O. (1967): Evidence for the identity of anionic centers of cholinesterases with cholinoreceptors. - Ann. N. Y. Acad. Sci. *144*, 689-693.

ACTA BIOL. SZEGED. 42, pp. 201-206 (1997)

NATURE/NURTURE IN GROWTH STUDIES

O. G. EIBEN

Department of Biological Anthropology, Eötvös Loránd University, H-1088 Budapest, Puskin u. 3. Hungary

(Received: December 10, 1996)

Abstract

The nature/nurture problem in human growth is outlined. The factors influencing growth and maturation are enumerated, and some results of the Hungarian National Growth Study are presented. The educational level of the parents is demonstrated to be one of the most efficacious factors influencing the growth and maturation process of children.

Key words: growth and maturation,Hungarian National Growth Study, educational level.

Introduction

At the end of the 20th century, scientists are increasingly turning to the problem of the growth and maturation of children. The complexity of this biological process is well known; it is influenced by internal and external factors. The favourable factors promote this process, while the unfavourable ones slow it down. It has long been known and is readiliy understandable that the growth and maturation of groups of children living under better socio-economic conditions outstrip those of their counterparts living under poorer circumstances (phenomenon of "hysteroplasia"; RIETZ, 1906).

The importance of this increased in the second half of the 20th century, when the distance between the various social classes/strata has markedly widened. This is true in different regions of the world, but especially in the developing countries and in the Eastern and Central European (ex-socialist) countries (EIBEN, 1996).

It is a scientifically proved fact that the somatic developmental status of children is an indicator of the nutritional and health status of the population (TANNER, 1986). Worldwide, scientists are carrying careful growth studies to establish the above-mentioned characteristics of their populations. Auxologists attempt to take into consideration all possible factors which can influence the growth and maturation process.

Factors influencing growth and maturation

The internal and external factors influencing the growth and maturation process can be classified as follows:

(1) The internal factors are inherited characters: the sex, the race of the child, his/her physique, and connected with this, the function of the endocrine system.

VERSCHUER (1934) described growth genes of first, second and third order. The growth genes of first order control the process of zygote division and then the beginning of cell differentiation. Those of second order regulate growth during embryologic and fetal life, and those of third order have a role in postnatal growth. As concerns the growth genes of first order, there is no difference within the human species. The growth genes of second order are racespecific. Beginning from the 4th fetal month, differences in race can be demonstrated. Individual differences can be observed in the effects of the growth genes of third order.

For a gross assessment of the degree of heritability, LERNER (1958) states that the phenotypic variation of a character consists of four components: the genotypic and peristatic (environmental) variation, the correlation between the two, and the interaction of the two. THOMA (1960) gives the following limiting values for the heritability of, for instance, menarcheal age: $88.2\% > H > 72.2\%$. Taking into consideration the inaccuracy factors and amplifying the estimation for the growth process generally, one can merely state that heritability cannot be lower than 70% (EIBEN, 1977).

The child's physique (constitution) consists of the manifested part of the genotype and of that part of the paratype (i.e. acquired characteristics) which is a result of permanent adaptation to the external effects (and which also depends on genetic factors). The temporary status, i.e. condition, does not belong to the constitution. There are lasting characteristics that have only local importance and the genetic endowments have no role in their development, e.g. marks of injuries, passing children's diseases, etc. (see SZABÓ, 1938). Obviously, growth and somatic development is a phenotypically highly variable and genetically controlled process.

(2) The external factors influencing the growth and maturation process are of two kinds: (a) natural/physical or geographic factors, and (b) social factors.

(2a) The natural/physical or geographic factors include the climate determined by the geographic situation, the local geomorphological conditions: highland or lowland, exposure to radiation, the soil with its mineral salts dissolved in the drinking water (cf. iodine and thyroxine production), etc.

(2b) The social factors influencing the growth and maturation process deserve special attention: the economic welfare and social position of a given family, and the education level and profession of the parents determine the nutritional customs and hygienic circumstances of the family. At the same time, however, the social/political system in which the population lives determines the medical care (prevention of diseases and epidemics, and treatment) and the level of the physical activity and sports, too. It is also important to take into account the early or late setting out of the children to work, the early or late consumption of alcohol, drugs, smoking, early or later started sexual life, etc. One must also consider the environmental effects of the scientific-technical revolution. As a consequence of industrialization, the environment is adversely affected by artificial light, which transforms the human biorhythm. Noise and other pollutants, an intensified tempo of life with psychological stimuli in the cities and nowadays also in the villages, and several other well-known factors included can be characterized overall by the expression: mode of life (EIBEN, 1988).

On the other hand, the cultural level of the family likewise is a meaningful factor. The educational level of the parents and their professions determine their position and possibilities in the society (BODZSÁR, 1975, 1991; FARKAS, 1986; EIBEN, 1989, 1994; EIBEN and PANTÓ, 1988). In this sense, it is easy to understand that nature, i.e. the genetic endowments, in this case the growth pattern, can be manifested insomuch as the family environment (including nurture) promotes this.

One of the most important biological effects of the social changes is a consequence of the urbanization: the migration of peoples from different regions (representing different populations) into the major industrial centres. As a consequence of these migrations, the (relative) equilibrium in the population in question changes, resulting in the "heterosis effect": children are taller than their parents. This also happened in Hungary, in such a small country.

An interrelationship can be seen between the hardly measurable social effects or changes and the population genetic changes manifested in such objectively measurable characters as the body measurements, primarily stature.

Some results of the Hungarian National Growth Study

In the early 1980s, the author organized and with his team carried out the first Hungarian national growth study. Their representative sample was regionally stratified and involved 41 000 healthy, 3-18-year-old boys and girls (the cleaned sample N=39.035), 1.5% of the overall Hungarian youth in question (EIBEN et al., 1991).

A detailed anthropometric programme (18 body measurements) was carried out and menarche/oigarche data were collected with the status quo method. Hand and wrist radiographs (on 16% of the sample), head and face measurements and sociodemographic data on the children's family were collected.

The Hungarian national growth study provided information about children's growth status and age differences, proportional changes, changes in body composition, changes in physique (somatotype components), and the maturation status of boys and girls (for further details, see EIBEN, 1989; EIBEN and PANTÓ, 1986, 1988; EIBEN et al., 1991). That survey led to the publication of the first Hungarian national growth standards (EIBEN and PANTÓ, 1986), the basic anthropometric growth data on the current Hungarian youth (EIBEN and PANTÓ, 1988) and a monographic report (EIBEN et al., 1991).

In the 6-18 year-old sample, physical fitness was also investigated, with seven motoric tests (BARABÁS, 1986; EIBEN et al., 1991).

As regards the sociodemographic data, the paternal/maternal age, the child's place in the sibling sequence, the number of brothers and sisters (measure of the family), and the professions of the parents (in this increasing order) influence the growth process of children, but differences in height according to these aspects were small. The educational level of the fathers and/or mothers, however, displayed a remarkable dissociation within the sample and proved to be the most important factor.

In the Hungarian national growth study, there were five categories of educational level, ranging from uncompleted primary school, through completed primary school, vocational training school (without a school-leaving certificate), specialized school and grammar school (both with a certificate), to a high school and/or university degree. It is worthy of mention that the educational level of the parents in the recent sample investigated was slightly higher than that of the economically active Hungarian population (EIBEN, 1994).

The means of height and other length measurements in the upper categories were above the national means and/or the 50th percentiles, and in the lower categories below them. Sons of fathers with an uncompleted primary school education were the shortest, sons of fathers with a completed primary school level were taller, sons of fathers with a vocational training school level were taller again, sons of fathers with a secondary school level were still taller, and sons of fathers with a high school or university level were the tallest. The higher the fathers' educational level, the taller their sons. In this group, the pubertal growth spurt also occurred earlier than in other groups of boys.

As concerns the educational level of the mothers, the boys exhibited a similar picture; indeed, in sons of mothers with a low educational level, backwardness in growth and maturation was more evident.

This phenomenon was even more expressed in girls, and especially in daughters of fathers and mothers with a low educational level, who were the shortest, and in daughters of fathers and mothers with a university degree, who were the tallest, particularly after puberty (for further details, see EIBEN, 1989).

Thus, the higher the educational level of the parents, the taller their sons and daughters. These differences between the two extreme social groups (6-7 cm) are significant in both sexes. The mothers' educational level seems to be more of a determinative factor in this respect than that of the fathers.

In the width and girth measurements of the trunk and the extremities and in the skinfolds there were only small differences, but a definitive tendency was observed: children of less educated parents displayed unfavourable biological (anthropometric) values in growth. This was especially the case for the means of the bicondylar width of the humerus, in particular in early childhood and prepuberty.

The onset of puberty in girls revealed the same tendency: the age at menarche in the lower categories was later by 4-7 months than in the upper categories (Table 1). This trend in Hungary was already known (EIBEN, 1972; BODZSÁR, 1975; 1991).

Based on her Bakony Growth Study, BODZSÁR (1991) qualified the parents' educational level as the most important indicator of the sociodemographic status of the family influencing the growth of children.

In the early 1980s, FARKAS investigated a large Hungarian sample (the majority of it originating from Southern Hungary) and analysed his material from many aspects. Among others, he observed that in daughters of mothers with a low educational level the menarche appeared later than in daughters of highly educated mothers: m=12.88 vs. 12.69 y. The corresponding analysis concerning the educational level of the fathers yielded similar results (FARKAS, 1986). These differences amount to about 2 months.

Table 1. Onset of puberty in Hungarian girls according to educational level of the parents based on the Hungarian national growth study (EIBEN, 1989).

Educational level of the parents	Age at menarche (medians in years)
Father	
Uncompleted primary school	13.07
Completed primary school	13.09
Vocational training school	12.99
Secondary school	12.61
High school/University	12.44
Mother	
Uncompleted primary school	12.93
Completed primary school	12.99
Vocational training school	12.83
Secondary school	12.86
High school/University	12.67
The whole Hungarian sample	12.79

Most factors causing differences in socio-economic groups more or less correlate with each other, e.g. the educational level and profession, since the earlier one partly determines the latter one. This is the reason why it is so difficult to separate the effects of certain ecological factors. A higher educational level is usually associated with a better nutrition, and better care of the infants and children. Additionally, these parents usually use social services better than others. For Hungarian children, the educational level of the parents is a determinant. The author is convinced that the cultural niveau is the most important social factor influencing the growth and maturation of the young. It seems important to point out the determining role of the mothers in creating a better cultural background for the family (EIBEN, 1989, 1996).

References

BARABÁS, A. (1986): Selected factors of physical performance in the Hungarian youth. - Anthropologiai Közlemények *30*, 233-242.

BODZSÁR, É. B. (1975): Data to Puberty of Girls. - Humanbiologia Budapestinensis *3*, 174.

BODZSÁR, É.B . (1991): The Bakony Growth Study. - Humanbiologia Budapestinensis *22*, 210.

EIBEN, O. G. (1972): Genetische und demographische Faktoren und Menarchealter. -Anthropologischer Anzeiger *33*, 205-212.

EIBEN, O. G. (1977): Some genetic aspects of human growth. In: SZABÓ, G. and PAPP, Z. (eds): Medical Genetics. - Excerpta Medica, Amsterdam-Oxford, Akadémiai Kiadó, Budapest 615-620 pp.

EIBEN, O. G. (1988): Secular Growth Changes in Hungary (in Hungarian). - Humanbiologia Budapestinensis, Suppl. *6*, 133.

EIBEN, O. G. (1989): Educational level of parents as a factor influencing growth and maturation. In TANNER, J. M. (ed.): Auxology 88. Perspectives in the Science of Growth and Development. - Smith-Gordon and Nishimura, London 227-234 pp.

EIBEN, O. G. (1994): Genetic aspects and/or effects of the environmental factors in human growth. In: JAI RUP SINGH (ed.): Human Genetics. Health and Disease Perspectives. - Ess Ess Publications, Delhi 253-258 pp.

EIBEN, O. G. (1996): Growth and maturation problems of children and social inequality over economic liberalisation in Central and Eastern Europe. - Cambridge University Press (in press).

EIBEN, O. G. and PANTÓ, E. (1986): The Hungarian national growth standards. - Anthropologiai Közlemények *30*, 5-23.

EIBEN, O. G. and PANTÓ, E. (1987/88): Body measurements in the Hungarian youth at the 1980s, based on the Hungarian national growth study. - Anthropologiai Közlemények *31*, 49-68.

EIBEN, O. G, BARABÁS, A. and PANTÓ, E. (1991): The Hungarian National Growth Study, I. Reference Data on the Biological Developmental Status and Physical Fitness of 3-18 Year-old Hungarian Youth in the 1980s. - Humanbiologia Budapestinensis *21*,123.

FARKAS, Gy. L. (1986): Relationships between the different factors and the age at menarche in Hungary. - Anthropologiai Közlemények *30*, 117-123.

LERNER, I. M. (1958): The Genetic Basis of Selection. - W. Sonn, New York.

RIETZ, E. (1906): Körperentwicklung und geistige Begabung. - Zeitschrift für Schulgesundheitspflege *19*, 65-98.

SZABÓ, Z. (1938): Physique and heredity. In: GERGELY, L. (ed.): New Data of Research on Physique (in Hungarian). - Budapest.

TANNER, J. M. (1986): Growth as a mirror of the condition of society: Secular trends and class distinctions. In: DEMIRJIAN, A. and BRAULT DUBUC, M. (eds): Human Growth: A multidisciplinary Review.

THOMA, A. (1960): Age at menarche, acceleration and heritability. - Acta Biologia Academiae Scientiarum Hungariae *11*, 241-254.

VERSCHUER, V. O. (1934): Die Erbbedingtheit des Körperwachstums. - Zeitschrift für Morphologie und Anthropologie *34*, 398-412.

ACTA BIOL. SZEGED. 42, pp. 207-209 (1997)

CHANGE IN BODY SIZE AND BODY COMPOSITION OF HUNGARIAN UNIVERSITY STUDENTS BETWEEN 1976 AND 1990

GY. GYENIS

Department of Biological Anthropology, Eötvös Loránd University, H-1088 Budapest, Puskin u. 3, Hungary

(Received: December 20, 1996)

Abstract

The mean height, mean weight and mean body mass index (BMI) are reported for two samples (n=11766) of first-year students at the Technical University in Budapest. The first sample was investigated in ten consecutive classes between 1976 and 1985, and the second one in five consecutive classes between 1986 and 1990. The values of the two body measurements and the BMI were larger in the second sample than in the first, which revealed the positive secular trends among Hungarian university students.

Key words: height, weight, BMI, university students, secular trends, obesity.

Introduction

The term "secular trend" has generally been used to denote the increases in height and weight during childhood and adolescence, the decrease in the age at menarche, and the increase in adult stature which have occurred since about the middle of the 19th century in Europe. The secular trends are complex phenomena influenced by environmental and socioeconomic conditions (MALINA, 1990). Although there has been a general tendency for these trends to continue worldwide in the recent past, a current lack of secular trends has also been reported (GARN and FRENCH, 1967; MARESH, 1972; VAN WIERINGEN, 1986); indeed, in some developing countries, negative secular trends (decreases in stature) have been observed (TOBIAS, 1985).

From Hungary, only positive secular trends has been reported (GYENIS and TILL, 1986; EIBEN, 1988; MÉSZÁROS et al., 1992; G. SZABÓ et al., 1993; SZÖLLŐSI and JÓKAY, 1994).

Secular trends can be detected not only in body measurements, but also in body composition. The body mass index (BMI: ratio of weight divided by the square of stature) correlates reasonably well with fatness (ROCHE et al., 1981), and it can therefore be used as an indicator of obesity.

The aim of this paper is to study the direction of the secular trends and the changes in body composition among Hungarian university students, investigated in two samples of first-year students at the Technical University in Budapest. The first sample consisted of 6 916 20-year-old male and 1 390 19-year-old female students in ten consecutive classes between 1976 and 1985, while the second sample comprised 2 289 20-year-old male and 571 19-year-old female students in five consecutive classes between 1986 and 1990.

Results

The mean height of the male students in the first sample was 176.92 cm, while in the second sample it was 178.01 cm (Table 1). Thus, the mean increase in height was more than 1 cm. The mean height of the female students showed the same tendency, the difference in mean height of the two samples (164.55 cm and 165.56 cm) again being more than 1 cm.

The mean weight in the first sample of male students was 68.87 kg, while in the second sample it was 70.86 kg; thus, the increase was almost 2 kg (Table 1). A similar tendency appeared for the female students, where the mean weight in the first sample was 56.29 kg, while in the second sample it was 58.05 kg, i.e. a difference of 1.76 kg between them.

Table 1. Mean height and mean weight of male and female students in 1976-85 and in 1986-90.

Period of investigation	Males					Females				
		Height (cm)		Weight (kg)			Height (cm)		Weight (kg)	
	n	M	SD	M	SD	n	M	SD	M	SD
1976-85	6 916	176.92	6.47	68.87	8.52	1 390	164.55	6.02	56.29	6.93
1986-90	2 889	178.01	6.40	70.86	9.23	571	165.56	5.93	58.05	7.44
Differences:		1.09		1.99			1.01		1.76	

The BMI of the male students (Table 2) showed an increase of 0.38, from 21.95 to 22.23. The increase in BMI for the female students agreed well with that for the male students, the difference between the mean BMIs of the two female samples (20.77 and 21.16) being 0.39.

Table 2. BMI for male and female students in 1976-85 and in 1986-90.

Period of investigation	Males			Females		
	n	M	SD	n	M	SD
1976-85	6 916	21.95	2.22	1 390	20.77	2.20
1986-90	2 889	22.33	2.47	571	21.16	2.39
Differences:		0.38			0.39	

Conclusions

The data presented here demonstrate that positive secular trends occurred in the height and weight of the students at the Technical University in Budapest in the period

1976-1990. The increases in both body measurements were very similar among the male and female students. There were also positive changes in the values of BMI for the male and female students. These latter suggest an increasing prevalence of overweight and obesity, as reported earlier (GYENIS, 1994, 1996).

Acknowledgement

This study was supported by the National Scientific Research Foundation (OTKA grant No.1/6/T 13098), for which the author is grateful.

References

EIBEN, O. (1988): Szekuláris növekedésvizsgálatok Magyarországon (Secular changes in Hungary; in Hungarian). - Humanbiol. Bp. Suppl. *6*, 133 pp.

GARN, S. M. and FRENCH, Y. (1967): Magnitude of Secular Trend in Fels Population. - Fels Research Institute, Yellow Springs, Ohio.

G. SZABÓ, T., GÖNCZI, A.. and NYILAS, K. (1993): A gyermekek testi fejlettségének változása az elmúlt 40 év alatt egy Hajdu-Bihar megyei településen. In: JOUBERT, K. (ed.): A Pediátriai-Antropológiai Szekció Tudományos Ülésén Elhangzott Előadások. - Budapest, 69-79 pp.

GYENIS, GY. and TILL, G. (1968): Secular changes of body measurements in Hungarian university students between 1976-1985. - Anthrop. Közl. *30*, 147-150.

GYENIS, GY. (1994): Az obesitas gyakorisága magyar egyetemi hallgatóknál (The frequency of obesity in Hungarian university students and the effects of the socio-economic factors on it; in Hungarian with English summary). - Anthrop. Közl. *36*, 56-57.

GYENIS, GY. (1996): Body mass index (BMI) in Hungarian university students. In: BODZSÁR, B. É. and SUSANNE, C. (eds): Studies in Human Biology. - Eötvös Univ. Press, Budapest, 343-348 pp.

MALINA, R. M. (1990): Research on secular trends in auxology. - Anthrop. Anz. *48*, 3, 209-227.

MARESH, M. (1972): A forty-five year investigation for secular changes in physical maturation. - Am. J. Phys. Anthrop. *36*, 103-109.

MÉSZÁROS J., FRENKL R., SZMODIS I. és MOHÁCSI J. (1992): A szekuláris trend vizsgálata a Testnevelési Főiskolára 1972-1981 között jelentkezett nőkön és férfiakon (A study of secular trend among the applicants to the Hungarian University of Physical Education between 1972 and 1981; in Hungarian with English summary). - Hung. Rev. Sports Med. *23*, 2, 97-102.

ROCHE, A. F., SIERVOGEL, R. M., CHUMLEA, W. C. and WEBB, P. (1981): Grading body fatness from limited anthropometric data. - Am. J. Clin. Nutr. *34*, 2831-2838.

SZÖLLŐSI, E. and JÓKAY, M. (1994): Changes in main body size values of Debrecen female university students. A review of five decades. In: EIBEN, O. G. (ed.): Auxology '94. - Humanbiol. Bp. *25*, 301-306.

TOBIAS, P. V. (1985): The negative secular trend. - Journ. Hum. Evol. *14*, 347-356.

WIERINGEN, J. C. van (1986): Secular growth changes. In: FALKNER, F. and TANNER, J. M. (eds): Human Growth *2*. - Plenum, New York, 445-473 pp.

ACTA BIOL. SZEGED. 42, pp. 211-216 (1997)

SOME DEMOGRAPHIC VARIABLES AND BODY DEVELOPMENT INDICES IN RELATION TO CHILD BEHAVIOUR

K. JOUBERT[1], S. DARVAY[2], R. ÁGFALVI[2], J. GÁDOROS[3] and S. RÓZSA[4]

[1]*Demographic Research Institute of the Central Statistical Office, Budapest,*
[2]*National Institute of Child Health, Budapest,*
[3]*Vadaskert Clinic and Foundation for Emotionally Disturbed Children, Budapest,*
[4]*Department of Personality and Clinical Psychology, Eötvös Loránd University, Budapest, Hungary*

(Received: December 14, 1996)

Abstract

Data on 4412 children aged 11-14 included in the Child Behaviour Checklist (CBCL) (ACHENBACH, 1991) on the basis of the Hungarian Longitudinal Representative Growth Study according to the following aspects. Certain demographic characteristics relating to the parents and some major body development indices of the children were investigated according to the main aspects of the CBCL scale: internalization and its indices (withdrawn, anxious, depressed behaviour), externalization and its indices (deviance and aggressive behaviour).

The strongly significant difference between the means of the dependent variables could basically be ascribed to the differences in educational level between the groups of mothers. This result is a verification of the fact that the level of education is a very good index (measure) of the cultural and social level and of the standard of health knowledge. The strongly significant difference of the means of the dependent variables concerning the mother's dwelling-place and the normal and pathological groups of the CBcl scales observed may be basically ascribed to the differences between the groups of mothers' dwelling-places.

Key-words: Child Behaviour Checklist (CBCL), Hungarian Longitudinal Representative Growth Study.

Introduction

Regular studies on the body development, growth and health conditions of children are nowadays general in developed countries.

However, our knowledge on mental health, on the frequencies of mental problems occurring in childhood, on the morbidity of a child psychiatric status and the related epidemiology is relatively insufficient. This can be explained by the psychiatric disorders involved being multifactorial in origin, so that their investigation is much more complex and intricate. Much help is provided towards the elimination of this paucity by surveys on the behaviour and attitudes of children, conducted mainly by using questionnaires, generally filled out by the parents. These surveys help in the detection of psychiatric problems of various importance. If such data are supplemented with information concerning the social, demographic, body development and morbidity status of the child and of the family; a background can be established for pinpointing the risk factors of the problems and behaviour.

Material and methods

The research results reported here are based on such a survey, and the associated behaviour and attitude study. The "National Longitudinal Child Growth Research" now being conducted under the professional direction of the authors started in 1979 under the title "Health and demographic study of pregnants and infants". The research program involved a national representative sample of 2 per cent, on the joint initiation of the Demographic Research Institute of the Hungarian Statistical Office, the Department of Population Statistics of the CSO, and the National Institute of Child Health. In the present study, 4412 parents described their children's emotional and behaviourial problems according to the ACHENBACH'S Child Behaviour Checklist (CBCL), (ACHENBACH, 1991). The ages of the children ranged from 11 to 14 years. Mean =12.74 years; SD = 0.93; 2131 were girls and 2281 were boys.

The children's emotional and behavioural problems were assessed by the Hungarian version of the widely-used CBCL, developed by ACHENBACH (ACHENBACH, 1991; GÁDOROS, 1996). The standardized rating scale of 114 items designed to obtain parents'reports of their children covered a wide range of problem behaviour, such as withdrawal, anxiety/depression, somatic complaints, social problems, thought problems, attention problems, delinquency and aggression, together with twenty competence items relating to the child's activities, social relations, involvement in social organizations, school performance and social competence. The total competence score is derived from the sum of the activity, social and school scales. Problem items are scored by parents on a 3-point scale (0 if the problem item does not hold for the child, 1 if the item is somewhat true or sometimes true, and 2 if it has been very true or often true in the preceding 6 months). Two broad-band groups of syndromes derived from the problem scales were designated "externalizing" or "internalizing". Externalizing problems reflect conflicts with other people and mainly concern aggressive and delinquent behaviour syndromes. Internalizing problems consist of the withdrawal, anxiety/depression and somatic complaints syndromes.

The variables included in the study were externalization and internalization, including the scales constituting them, the mother's educational level, the type of settlement of her habitation, her age, the child's body mass, body mass index (BMI), and head circumference at birth, and those at the age of 10 years.

The interrelations between the variables studied were analysed by two-way analysis of variance (ANOVA).

Results

The mother's educational level

Withdrawn behaviour scale - depending on the normal or pathological value, strongly significant differences were observed for boys between the mean head circumferences at birth and at the age of 10. ($p< 0.01$; in the following, the differences between means that are indicated to be statistically strongly significant are always at this level). For girls a strongly significant difference was also found between the means of the head circumference at birth and at 10 years of age.

Anxious/depressed behaviour scale - depending on the normal/pathological distribution, the difference was also strongly significant between the means of the head circumference at birth and at age 10, but, only for boys .

Somatic complaints scale - depending on normal and pathological grouping, the means of the head circumference at birth and at age 10 and also of the body mass at birth exhibited strongly significant differences for boys. In the case of girls, no statistically significant difference was found between the means.

Internalization (sum of the above three scales) - depending on the normal or pathological values the head circumference means at birth (Fig. 1) and at age 10 displayed strongly significant differences, but only in the case of boys.

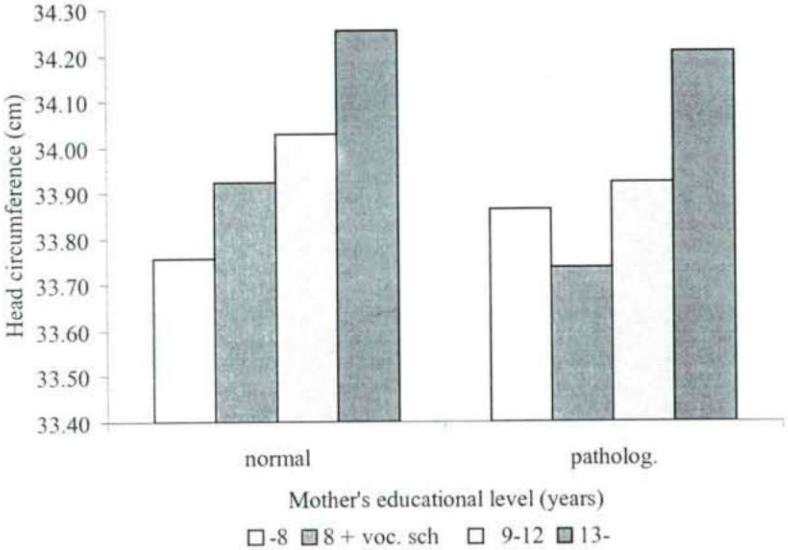

Fig. 1. Mean head circumference at birth as a function of the mother's educational level and the child's internalization (boys).

Delinquent behaviour scale - depending on the normal or pathological groups, between the means of the head circumference at age 10 were strongly significantly different for girls. The means of head circumference at birth and at age 10 and of the body mass at birth were all strongly significantly different for boys.

Aggression scale - depending on the normal or pathological distribution, strongly significant differences were observed between the means of the body mass at birth, and also the head circumference at birth and at age 10, but only in the case of boys.

Externalization scale (the sum of the previous two scales) - The normal and pathological groups of boys exhibited strongly significant differences in body mass at birth, and in head circumference at birth and at age 10 (Fig. 2), while for girls only the means of the head circumference at birth differed significantly.

The strongly significant differences between the means of the dependent variables can basically be ascribed to the differences in educational level between the groups of mothers. This verifies that the level of education is a good index (measure) of the cultural and social level and of the standard of health knowledge (JOUBERT, 1982; EIBEN, 1989; GÁRDOS and JOUBERT, 1991).

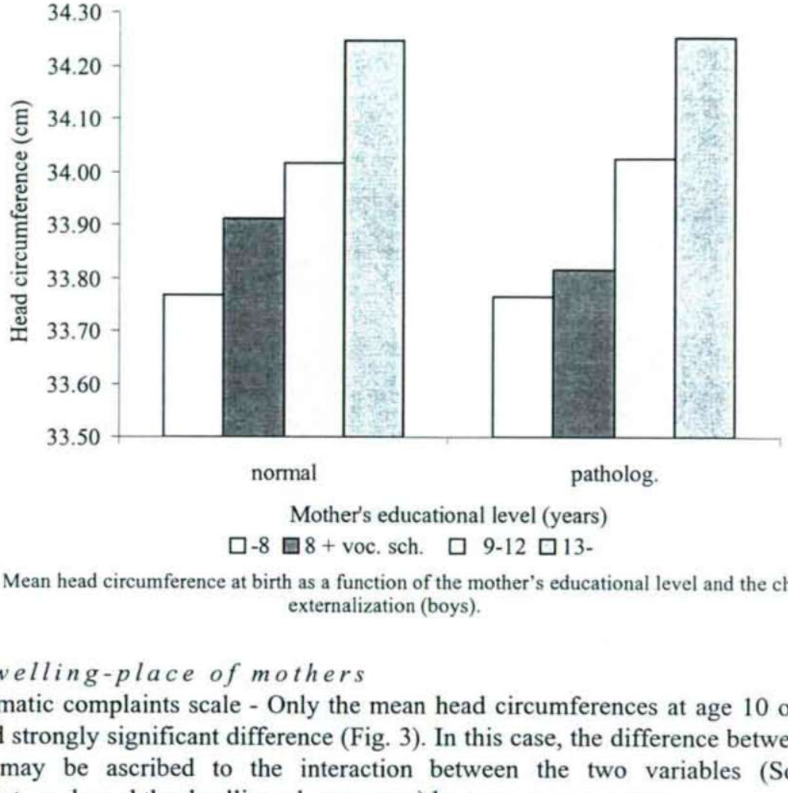

Fig. 2. Mean head circumference at birth as a function of the mother's educational level and the child's externalization (boys).

Dwelling-place of mothers

Somatic complaints scale - Only the mean head circumferences at age 10 of girls revealed strongly significant difference (Fig. 3). In this case, the difference between the means may be ascribed to the interaction between the two variables (Somatic complaints scale and the dwelling-place groups) by a common measure.

Internalization scale - Only the mean body mass of boys at age 10 yielded a strongly significant difference, which may be ascribed mainly to the interaction between the two variables (groups of Internalizing scale and of dwelling-place).

Aggression scale - Only the mean body mass index of boys at birth showed a strongly significant difference, which may be ascribed mainly to the differences between the dwelling-place categories, and to a smaller extent to the joint effect of the two variables.

Externalization scale - Only the mean body mass at birth of girls gave a strongly significant difference. Not in the way stated above, in this case the difference between normal and pathological groups explain the differences between the means.

The age of mother

Anxious/depressed behaviour scale - Only the mean body mass of girls at birth (Fig. 4) displayed a strongly significant difference.

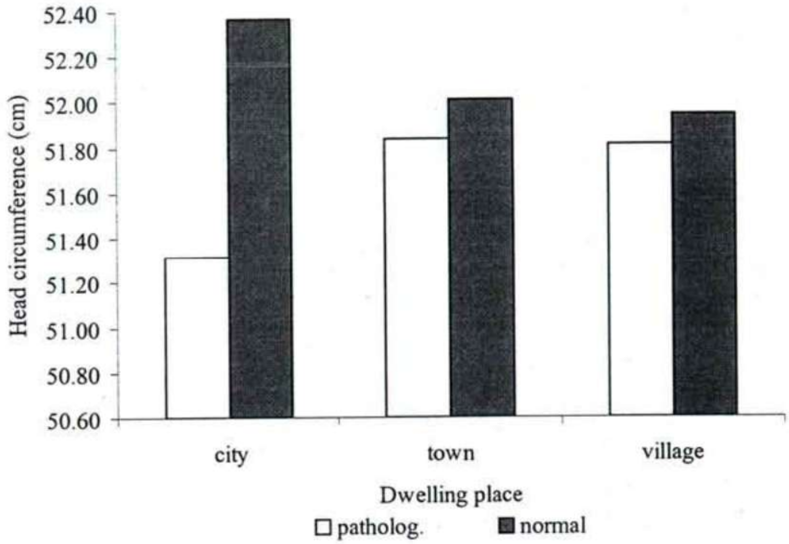

Fig. 3. Mean head circumference at the age of ten as a function of the dwelling-place of the mother and the child's Somatic complaints (girls).

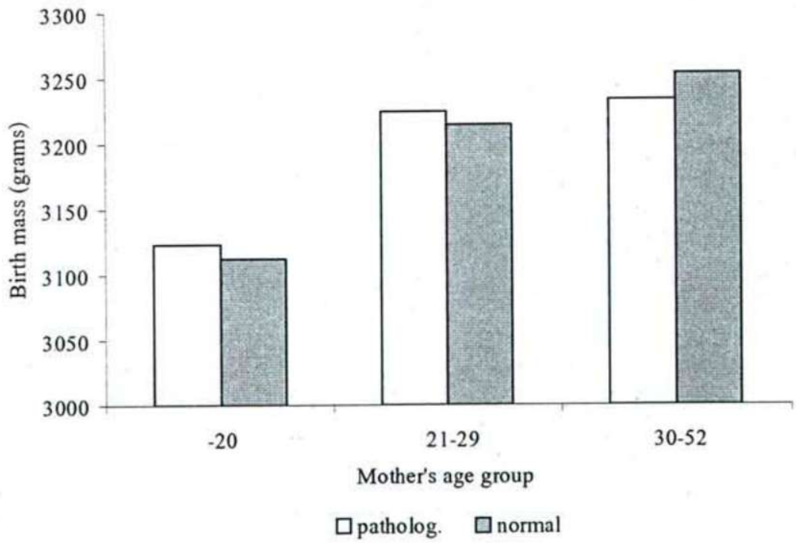

Fig. 4. Mean mass at birth as a function of the mother's age group and the child's Anxious/Depressed behaviour (girls).

Somatic complaints scale - Strongly significant differences were observed between mean body mass index of boys at birth, the mean head circumference of boys at birth, the mean body mass of girls at birth.

Internalization scale - Strongly significant differences were observed between the mean body mass of boys at birth, the mean body mass of girls at birth and the mean head circumference of girls at age 10.

Delinquent behaviour scale - Strongly significant differences for boys were found only in the mean head circumference at age 10. For girls, the mean body mass at birth and the mean body mass index at birth exhibited strongly significant differences.

Aggression scale - Only the mean body mass of girls at birth and the mean body mass index of girls at birth showed strongly significant differences.

Externalization scale - A strongly significant difference was found only in the case of mean body mass of girls at birth .

The strongly significant differences between the means of the dependent variables examined according to the mother's dwelling-place and the normal and pathological groups of the CBCL scales may be ascribed basically to the differences between the groups of mothers' dwelling-places.

The examination of the interrelations between the normal and pathological data on the CBCL scales and demographic variables and anthropometric data included in the analysis revealed certain relations, which demonstrates that it is worthwhile to continue this work in more detail, including further variables.

References

ACHENBACH, T. M. (1991): Manual for the Child Behavior Checklist: 4-18 and 1991 Profile. - Burlington, VT, University of Vermont, Department of Psychiatry.

EIBEN, O. G. (1989): Educational level of parents as a factor influencing growth and maturation. In: TANNER, J. M. (ed.): Auxology '88. Perspectives in Science of Growth and Development. - Smith-Gordon-Nishimura, London, Niigata-Shi, 227-234 pp.

GÁDOROS, J. (1996): Szociodemográfiai rizikótényezők vizsgálata a Gyermekviselkedési Kérdőív alkalmazásával. - Psychiatria Hungarica *11*, 147-166.

GÁRDOS, É. and JOUBERT, K. (1991): Newborn's development by sociodemographic factors in a representative survey. - Anthrop. Közl. *33*, 54-64.

JOUBERT, K. (1982): Distribution of the new-born with low birth-weight by some demographic characteristics on the basis of national data on live-births in 1975. - Humanbiol. Budapestinensis *12*, 187-197.

JOUBERT, K. and GÁRDOS, É. (1991): Terhesek és csecsemők egészségügyi és demográfiai vizsgálata. A kutatási program általános ismertetése (Health and demographic study of pregnant women and infants. General review of the research project). - KSH Népességtudományi Kutató Intézet Kutatási Jelentései *40*, 82 pp.

ACTA BIOL. SZEGED. 42, pp. 217-223 (1997)

SUPERNUMERARY OCCLUSAL CUSPS

G. KOCSIS S. and A. KOCSIS

Clinic of Dentistry and Oral Surgery, Albert Szent-Györgyi Medical University, H-6720 Szeged, Tisza Lajos krt. 64., Hungary

(Received: December 10, 1996)

Abstract

Supernumerary (central) cusps which can appear on the occlusal surface of the teeth, have already been grouped by many scientists. The most comprehensive grouping of the premolar cusps is that by SCHULZE (1987). However, particular occlusal cusp forms may occur on the molar teeth, and cusp-like protrusions may develop on the incisors and the canine teeth, though these are not identical with the palatal (talon) cusp.

Occlusal cusp forms on the premolar teeth may be as follows: 1. cone-like reinforcement of the lingual cusp, 2. supernumerary occlusal cusp appearing lingually, independently from the lingual cusp, 3. dens evaginatus protruding from the buccal cusp or the occlusal groove, 4. occlusal enamel pearl, 5. lingual protrusion of the buccal cusp, 6. occlusal cusp formation in lobodontia syndrome.

The various forms of occlusal cusps can be distinguished by the following criteria: morphological characteristics, the relation of the particular forms to tooth types, and racial relationship. A distinction would allow determination of the ethnicity of the dentition.

Key words: occlusal cusps, premolar, molar, other teeth, morphological characteristics, racial relationship.

Introduction

On the occlusal surface of the teeth, the contact surface of the upper and lower premolars and molars, can be found several cusps. The upper premolars and the first lower premolars have 2, the second lower premolars 2 or 3, the upper molars 3 or 4, and the lower molars 4 or 5 cusps.

The supernumerary cusps of the molars (6th and 7th cusps) can develop among the normal number of cusps situated vestibularly or orally next to each other. The Carabelli, paramolar and other cusps may be found on the vestibular and oral crown surfaces of the premolars and, more often, the molars (MORRIS, 1967; SCHULZE, 1987).

The occlusal supernumerary cusps are the central cusps among those on the occlusal surface on the buccal and lingual side. The first description was that by LEIGH (1925), who reported an enamel tubercle on the occlusal surface of the third upper right molar of an Eskimo skull. The different forms of these tubercles were grouped according to their situations and shapes by LAU (1955), MERRILL (1964), and SCHULZE

(1987), mainly for premolars. However, these cusps may also be found, though in different forms, on the molars, and they have also been described (LAU, 1955; OEHLERS, 1956; ALLWRIGHT, 1958; MERRILL, 1964), on the incisors and the canine teeth. They are not to be confused with the enlarged palatine tubercle, the talon cusp (MELLOR and RIPA, 1970).

Forms of occlusal cusps

LAU (1955) set up two groups: cusps grown out of buccal cusps, and cusps grown out of the middle of the occlusal surface. They can be smooth, grooved, terraced or ridged.

MERRILL (1964) accepts LAU's conclusion of two groups on the premolars. In the first group, the protrusion appears on the lingual ridge of the buccal cusp; in the second, it arises from the groove. The second group involves a sub-group: the double lingual cusp (MERRILL observed one case, on a lower tooth).

SCHULZE (1987) distinguished six different shapes on the premolars, and stated that they are mainly characteristic of the Mongoloid race, and rare in other populations. The shapes are as follows:

1. A cone-like enlargement of the lingual cusp. This is a gradually strengthening serial characteristic, with the following phases:

1/a. A cone-shaped oral cusp reinforced in the vestibular direction.

1/b. A significantly enlarged lingual cusp with distict marginal wrinkles.

1/c. A separately developed central cusp on the lingual crown side. The marginal wrinkles merge and form a cingulum.

2. Similar to the previous one, but here the original lingual cusp is clearly seen beside the central cusp. As described earlier (KOCSIS, 1984), it occurs in Europoids, too.

3. This is the best-known central cusp. JYOJIMA (1929), MATSUMURA (1934), and YUMIKURA and YOSHIDA (1936) described such occlusal cusp formation on the premolars. In the first frequency study, KATO (1937) found 1.09% on the premolars of the Japanese.

An earlier article (KOCSIS, 1984) listed 13 names for this disorder. YIP (1974) recommends the term dens evaginatus, used by several authors previously, and still accepted today.

The practical significance of the disorder is that, during the use of the tooth, the elevation sooner or later becomes damaged, breaks off or wears away. In a large majority of the cases, the root canal opens and the pulp chamber becomes infected. As a result of the malocclusion of the teeth, complications can develop: there will be an irregular development of the root, and the tooth will become irregularly positioned and loose.

Evagination can accompany other developmental irregularities. YIP (1974) found invagination, an extra premolar and mesiodens. SENIA and REGEZI (1974) reported the evagination of premolars and also lower three-rooted molars.

This type of occlusal cusp has been described only on premolars in the LAU (1955) and MERRILL (1964) classification. Cusps on molars and occlusal pearls are not included in the evagination referred to above. The evagination that appears on canines and incisors is also of a different character, but it has the same practical significance as a result of the vulnerability of the elevation (LAU, 1955; OEHLERS, 1956; ALLWRIGHT, 1958; MERRILL, 1964; GOTO et al., 1979; SHEY and EYTEL, 1983).

Table 1. The prevalence of dens evaginatus, and its racial relationship

Year of paper	Author(s)	Investigated population	No. of affected persons	%
1936	Yumikura and Yoshida	Japanese	17	-
1937	Kato	Japanese	-	1.09
1949	Pedersen	Eskimo (Greenland)	5	0.50
1955	Lau	Chinese	27	1.29
1955	Wu	Chinese	19	1.44
		Chinese	16	1.52
1956	Oehlers	Malays	110	-
1959	Sumiya	Japanese	-	1.88
1964	Merrill	Eskimo (Amerindian)	28	4.30
1967	Oehlers et al.	Chinese (Malays)	43	-
1970	Curzon et al.	Eskimo (Canada)	12	3.00
1974	Yip	Chinese	21	3.60
		Malay	3	1.10
		Indo-europoid	-	-
1975	Reichart and Tantiniran	Thai	51	1.01
1979	Goto et al.	Japanese	53	0.12
1980	Lin and Roan	Chinese (Taiwan)	305	3.52
1956	Villa	Filipino	1	-
1959	Villa et al.	Filipino	2	-
1965	Poyton and Vizcarra	Filipino	1	-
1974	Senia and Regezi	Filipino	1	-
1973	Palmer	Caucasian (British)	5	-
1974	Sykaras	Caucasian (Greek)	1	-
1977	Pearlman and Curzon	Negro	1	-
1981	Ciechanowski and Sonnenberg	Negroid	1	-

This type of cusp appears in ethnic groups that belong in the Mongoloid race, with a frequency of 0.5-4.3 (Table 1.); the term Mongoloid or oriental premolar reflects this (CURZON et al., 1970; REICHART and TANTINIRAN, 1975). It appears with different frequencies in the Japanese, Chinese, Malayan, Eskimo, Indian and Thai populations. A number of authors (POYTON and VIZCARRA, 1965; SENIA and REGEZI, 1974; VILLA, 1956; VILLA et al., 1959) have described evagination on premolars in Filipinos. The Filipinos are a mix of Mongoloid and European peoples, a Eurasian ethnic group, though according to LIPTÁK (1980) they are more Mongoloid.

As regards Negroids, the literature mentions only two cases so far. One case of dens evaginatus was found by PEARLMAN and CURZON (1977), on the second left lower premolar of a black boy, and the other by CIECHANOWSKI and SONNENBERG (1980), on both the lower first, and the second right premolar of a girl. In the latter case, one of the girl's great-grandmothers was part Cherokee Indian, but the teeth of her parents and sibling showed no evidence of the anomaly.

The above form of dens evaginatus is also very rare in Europeans. PALMER (1973) described it in four British boys and considered that the accentuated lingual aspect of the buccal cusp on the premolars of the sister of one of the boys was also a dens evaginatus. SYKARAS (1974) found this anomaly on the premolars of a Greek girl. A further case was reported by DOYLE (1970): a palatinal elevation on the upper front teeth of a Norwegian boy. However, his description lacked precise documentation, so it is considered inconclusive. Similarly, a dens evaginatus observed on the upper first incisor (SHEY and EYTEL, 1983) should be regarded as a talon cusp.

4. An extra occlusal cusp is situated on the lingual surface of the vestibular cusp. It looks like an enamel pearl; the authors' term refers to this. NISHIJIMA et al. (1959) described it in Japanese as a "central tubercle on the lingual ridge of the buccal cusp of the upper bicuspid". Probably the same thing was described by PEDERSEN (1949) when he talks about "a peculiar enamel pearl-like 'cusp' on the occlusal surface" on the right upper molar of an Eskimo from Greenland. He believed that a case described by LEIGH (1925) in an American Eskimo was the same. He reported an occurrence (occlusal pearl) on an upper second premolar, in two cases unilaterally on lower second premolars, and bilaterally on a second and a first premolar pair. According to PEDERSEN, "in the East Greenland Eskimo dentition we meet with anatomical features the significance of which, if any, is obscure, ... the occlusal pearl-like excrescences."

5. KIRVESKARI et al. (1972) described the bulging of the lingual aspect of the buccal cusps in Lapps. It was observed on the buccal aspect of the buccal cusps of premolars, and also on the mesiobuccal cusp of molars. It has a symmetrical appearance and is more frequent on the upper teeth and also on the second premolars and first molars. The third molar is the least affected. Occasionally, it is to be found on the lingual aspect of canines. The dentin base does not show this bulge. The same was observed by KUTSCHA (1985) on the individual cusps. SCHULZE (1987) considered that it is population-specific; in spite of this, it has often been observed in both historical and recent findings, on both premolars and molars. KIRVESKARI et al. (1972) also believed that it occurs frequently in Northern populations. It seems likely that the accentuated lingual ridges of the buccal cusps on the premolars of a British girl mentioned by PALMER (1973) also belongs here.

6. A syndrome-forming characteristic that relates to the extra occlusal cusp is the occurrence of central cusps in lobodontia. A case was presented in this journal earlier (KOCSIS et al., 1994). The descriptions mention the appearance of occlusal cusps on both premolars and molars. Among others, ROBBINS and KEENE (1964), SHUFF (1972), EKMAN-WESTBORG and JULIN (1974), SCHULZE (1976), CASAMASSINO et al. (1978) and BROOK and WINDER (1979) describe the formation of an irregular cusp, with irregular patterns on the occlusal surface of premolars and molars. This group includes bulging buccal and extra lingual and occlusal cusps, as well as the atypical multitubercular chewing surface of molars, with the occasional appearance of central cusps.

Discussion

The appearance of extra occlusal cusps has been seen to be a generic term which includes numerous, well-differentiated characteristics. One basis of differentiation is the morphological appearance, i.e. the deformation of the lingual or vestibular cusp or the appearance of an extra cusp not related to these. The other is the way the individual morphological forms are connected with the type of teeth. All central cusps described by the above authors (LAU, 1955; MERRILL, 1964; SCHULZE, 1987) appear on premolar teeth. Molar teeth exhibit a cusp system, which results in the teeth becoming rosette-shaped (ROBBINS and KEENE, 1964; SCHULZE, 1976; CASAMASSIMO et al., 1978), occasionally together with a cusp on the occlusal surface in lobodontia syndrome. An extra molar cusp on the occlusal surface can appear irrespective of this (LAU, 1955; MERRILL, 1964; OEHLERS et al., 1967). The molars also display bulging of the lingual aspect of the mesiobuccal cusp, and the occlusal enamel pearl described by LEIGH (1925), PEDERSEN (1949), NISHIJAMA et al. (1959) and ALEXANDERSEN and DAHLBERG (1967). The evagination, i.e. the elevation of the lingual ridge of incisors and canines, likewise belongs in this category (LAU, 1955; ALLWIGHT, 1958; MERRILL, 1964; KIRVESKARI et al., 1972; GOTO et al., 1979). The elevated incisor lobes that appear in lobodontia are also included here (ROBBINS and KEENE, 1964; SCHULZE, 1976; BROOK and WINDER, 1979; KOCSIS et al., 1994).

Another typical characteristic is the racial correlation, according to which types 1, 2, 5 and 6 occur in all (?) populations. In contrast, types 3 and 4 tend to appear in Mongoloid and Europomongoloid (Eurasian) populations and sporadically in other races.

The correlation between the disorder and biological sex is uncertain. According to YOSHIOKA and URANO (1963), YIP (1974) and GOTO et al. (1979) considered that there is no difference between its appearance in males and females; others (SUMIYA, 1959; OEHLERS et al., 1967) found it more frequently in men, whereas LAU (1955), MERRILL (1964), CURZON et al. (1970) and REICHART and TANTINIRAN (1975) believed it to occur more often in women. CURZON et al. (1970) described a three times higher frequency in women, and therefore suggested a correlation with the X chromosome. The racial correlation of the irregularity, and the examination of a few families (MERRILL, 1964; OKA et al., 1964) indicate that the dens evaginatus is inherited autosomatically and dominantly (STEWART et al., 1978). At the same time, PEARLMAN and CURZON (1977) considered it a developmental aberration.

On the above basis, we think that, in the event of a precise differentiation between the above cusp forms, it is possible to establish the racial identity of the examined dentition.

References

ALEXANDERSEN, V. and DAHLBERG, A. A. (1967): IADR Program and Abstracts of Papers, No *372*.

ALLWRIGHT, W. C. (1958): Odontomes of the Axial Core Type as a Cause of Osteomyelitis of the Mandible. - Br. dent. J. *104*, 363-365.

ALLWRIGHT, W. C. (1970): Letters to the Editor: "Evaginated Odontomes in the Keewatin Eskimo". - Br. dent. J. *129*, 451.

BAZAN, M. T. and DAWSON, L. R. (1983): Protection of dens evaginatus with pit and fissure sealant. - J. Dent. Child. *50*, 361-363.

BROOK, A. H. and WINDER, M. (1979): Lobodontia - a Rare Inherited Dental Anomaly. Report of an Affected Family. - Br. dent. J. *147*, 213.

CASAMASSIMO, P. S., NOWAK, A. J., ETTINGER, R. L. and SCHLENKER, D. J. (1978): An unusual triad: Microdontia, taurodontia, and dens invaginatus. - Oral Surg. Oral Med. Oral Pathol. *45*, 107.

CIECHANOWSKI, D. J. and SONNENBERG, E. M. (1981): Dens evaginatus in a negroid girl: report of case. - J. Dent. Child. *48*,450-452.

COON, C. S. (1962): The Origin of Races, pp. 356-357.

CURZON, M. E. J., CURZON, J. A. and POYTON, H. G. (1970): Evaginated Odontomes in the Keewatin Eskimo. - Br. dent. J. *129*, 324-328.

CURZON, M. E. J. (1970): Letters to the Editor: "Evaginated Odontomes in the Keewatin Eskimo". - Br. dent. J. *129*, 451.

DIXON, G. H. and STEWART, R. E. (1976): Genetic Aspects of Anomalous Tooth Development. In: Stewart, R. E. and Prescott,G. H. (eds): Oral Facial Genetics. St. Louis. The C. V. Mosby Co., 129 pp.

DOYLE, A. J. (1970): Letters to the Editor: "Evaginated Odontomes" - Br. dent. J. *129*, 402.

EKMAN-WESTBORG, B. and JULIN, P. (1974): Multiple anomalies in dental morphology: Macrodontia, multituberculism, central cusps, and pulp invaginations. - Oral Surg. Oral Med. Oral Pathol. 38, 217-222.

GOTO, T., KAWAHARA, K., KONDO, T., IMAI, K., KISHI, K. and FUJIKI, Y. (1979): Clinical and radiographic study of dens evaginatus. - Dentomaxillofac. Radiol. *8*, 78-83.

JYOJIMA, T. (1929): Occlusal anomalous tubercle on premolars. - Nihon no Shikai. *109*, 257.

KATO, K. (1937): Contribution to the Knowledge Concerning the Cone-Shaped Supernumerary Cusp in the Center of the Occlusal Surface on the premolars of Japanese. - Nihon Kyosei-Shika Gakkai Zasshi. *30*, 28-49.

KEENE, H. J. and DAHLBERG, A. A. (1973): Lobodontia. In: BERGSMA, D. WILLIAMS and WILKINS (eds): Birth Defects Atlas and Compendium. Baltimore, 581 pp.

KIRVESKARI, P., HEDEGARD, B. and DAHLBERG, A. A. (1972): Bulging of the Lingual Aspects of Buccal Cusps in Posterior Teeth of Skolt Lapps from Northern Finland. - J. Dent. Res. *51*, 1513.

KOCSIS, S. G. (1984): Dens evaginatus. - Fogorv. Szle. *77*, 142-146.

KOCSIS, S. G., SZENTPÉTERY, A., KOCSIS, A. and L.-KOKAI, E. (1994): Lobodontia. - Acta Biol. Szeged. *40*, 77-84.

KUTSCHA, B. (1985): Morphologische Variationen und Anomalien im Prämolarenbereich bei 1400 kieferorthopädischen Patienten. Med. Diss. Berlin. - Cit. : SCHULZE, Ch. (1987): Anomalien und Missbildungen der menschlichen Zähne. - Quintessenz Verlags-GmbH Berlin, Chicago, London, Sao Paulo, Tokio, pp: 94, 100.

LAU, T. C. (1955): Odontome of the Axial Core Type. - Br. dent. *J*. 99, 219-225.

LEIGH, R. W. (1925): Dental Pathology of the Eskimo. - Dent. Cosmos *67*, 884-898.

LIN, L. C. and ROAN, R. T. (1980): Incidence of dens evaginatus investigated from three junior middle schools at Kaohsiung City. - Formosan Sci. *34*, 113-121.

LIPTÁK, P. (1980): Embertan és emberszármazástan. - Tankönyvkiadó, Budapest, 269-279pp.

MATSUMURA, S. (1934): Supernumerary cusp on the occlusal surface of the human premolar. - Nihon Shikagakukai Zasshi. *27*,464.

MELLOR, J. K. and RIPA, L. W. (1970): Talon cusp: a clinically significant anomaly. - Oral Surg. Oral Med. Oral Pathol. *29*, 225-228.

MERRILL,R. G. (1964): Occlusal Anomalous Tubercles on Premolars of Alaskan Eskimos and Indians. Oral Surg. Oral Med. Oral Pathol. *17*, 484-496.

MOORREES, C. F. (1957): The Aleut Dentition: A Correlative Study of Dental Characteristics in an Eskimoid People. - Harvard Univ. Press, Cambridge, 29, and 49 pp.

MORRIS, D. H. (1967): Maxillary Premolar Variation Among the Papago Indians. - J. Dent. Res. *46*, 736-738.

NISHIJIMA, S., YOSHIDA, S., KOBAYASHI M. and YUTAKA, K. (1959): Several cases of central tubercle on the lingual ridge of buccal cusp of upper bicuspid. - J. Osaka Univ. dent. Soc. *4*, 1207-1212.

OEHLERS, F. A. C. (1950): Leong's Premolar. - Proc. Alumni Assoc. King Edward College Med. Singapore, *3*, 30.

OEHLERS, F. A. C. (1956): The Tuberculated Premolar. - Dent. Pract. Dent. Rec. *6*, 144-148.

OEHLERS, F. A. C., LEE, K. W. and LEE, E. C. (1967): Dens Evaginatus (Evaginated Odontome). Its structure and responses to external stimuli. - Dent. Pract. Dent. Rec. *17*, 239-244.

OKA, M., IGARASHI, S., TOMITA, R. and TSUKANO, H. (1964): Central cusp on the occlusal surface of premolar found in one sister and two brothers and a case of radicular cyst associated with the tubercle. - J. Japan stomat. Soc. *14*, 52.

PALMER, M. E. (1973): Case reports of evaginated odontomes in Caucasians. - Oral Surg. Oral Med. Oral Pathol. *35*, 772-779.

PEARLMAN, J. and CURZON, M. (1977): An Evaginated Odontome in an American Negro: Report of Case. - JADA *95*, 570.

PEDERSEN, P. O. (1949): The East Greenland Eskimo Dentition. - Meddelelser on Grönland. Vol. *142*. Bianco lunos, Copenhagen. pp: 85, 156, 163, 165, 214.

POYTON, H. G. and VIZCARRA, E. R. (1965): Three Evaginated Odontomes: Case Report. - J. Can. Dent. Assoc. *31*, 439-442.

REICHART, P. and TANTINIRAN, D. (1975): Dens evaginatus in the Thai. An evaluation of fifty-one cases. - Oral Surg. Oral Med. Oral Pathol. *39*, 615-621.

REICHART, P. A., METAH, D. and SUKASEM, M. (1982): Morphologic findings in dens evaginatus. - Int. J. Oral Surg. *11*, 59.

ROBBINS, I. M. and KEENE, H. J. (1964): Multiple Morphologic Dental Anomalies: Report of a Case. - Oral Surg. Oral Med. Oral Pathol. *17*, 683.

SCHULZE, Ch. (1976): Erbbedingte Formanomalien sämtlicher Zähne - ein neues Syndrom? - ZWR 85, 80-*84*, 178-182.

SCHULZE, Ch. (1987): Anomalien und Missbildungen der menschlichen Zähne. - Quintessenz Verlags-GmbH Berlin, Chicago, London, Sao Paulo, Tokio, 94-101 pp.

SENIA, E. S. and REGEZI, J. A. (1974): Dens evaginatus in the etiology of bilateral periapical involvement in caries-free premolars. - Oral Surg. Oral Med. Oral Pathol. *38*, 465-468.

SHEY, Z. and EYTEL, R. (1983): Clinical management of an unusual case of dens evaginatus in a maxillary central incisor. - JADA. *106*, 346-348.

SHUFF, R. Y. (1972): Patient With Multiple Conical Teeth. - Dent. Pract. *22*, 414.

STEWART, R. E., DIXON, G. H. and GRABER, R. B. (1978): Dens evaginatus (tuberculated cusps): Genetic and treatment consideration. - Oral Surg. Oral Med. Oral Pathol. *46*, 831-836.

SUMIYA, Y. (1959): Statistic Study on Dental Anomalies in the Japanese. - J. Anthropol. Soc. Nippon, Jinruigaku Zasshi *67*, 215-233.

SYKARAS, S. N. (1974): Occlusal anomalous tubercle on premolars of a Greek girl. - Oral Surg. Oral Med. Oral Pathol. *38*, 88-91.

TRATMAN, E. K. (1949): An Unrecorded Form of the Simplest Type of the Dilated Composite Odontome. - Br. dent. J. *86*, 271-275.

VILLA, V. G. (1956): Chronic Periapical Abscess with External Sinus Associated with the So-called "Leong's Premolar". - Philippines Med. Dent. J. *2*, 19.

VILLA, V. G., BUNAG, G. A. and RAMOS, A. B. Jr. (1959): Developmental Anomaly in the Form of an Occlusal Tubercle With Central Canal Which Serves as a Pathway of Infection to the Pulp and Periapical Region. - Oral Surg. Oral Med. Oral Pathol. *12*, 343-348.

WU, K. L. (1955): Survey on mid-occlusal tubercle in bicuspids. - China Stomat. *3*, 294.

YIP, W. K. (1974): The prevalence of dens evaginatus. - Oral Surg. Oral Med. Oral Pathol. *38*, 80.

YOSHIOKA, T. and URANO, J. (1963): The prevalence of abnormal enamel-covered tubercle. - Shikagakuho. *63*, 476.

YUMIKURA, S. and YOSHIDA, K. (1936): Abnormal cusp on the occlusal surface of the human premolar. - J. Japan stomat. Soc. *10*, 73.

ACTA BIOL. SZEGED. 42, pp. 225-234 (1997)

DETERMINATION OF BODY LENGTH AND AGE OF HUMAN FOETUSES AND NEWBORNS ON THE BASIS OF WEIGHTS OF LIMB BONES

F. KÓSA

Department of Forensic Medicine, Albert Szent-Györgyi Medical University, Szeged, Hungary

(Received: December 10, 1996)

Abstract

Weight measurements were carried out on the collection of foetal and newborn skeletons at the Department of Forensic Medicine, Albert Szent-Györgyi Medical University, Szeged, for age determination purposes.

On an automatic calibrated scale, the weight of the diaphysis of the limb bones (humerus, radius, ulna, femur, tibia and fibula) of 79 5-10 - lunar month - old foetuses and newborns (42 male, 37 female) were measured to milligram accuracy, and statistical methods were then applied to determine the relationship between the body length and age of the foetuses and the weight of the limb bones.

Linear regression did not reveal any correlation between the weights of the limb bones and the body lengths of the foetus. On the exponential regression line, however, the points fitted well. The correlation coefficients indicated a close correlation (values in the range +0.83-0.96). This means that, in the lack of other more reliable data, the limb bone weights can be considered in determination of the age of an unknown foetus/newborn.

Key words: body length and age determination of human foetuses and newborns, weights of limb bones, forensic medical and paleoanthropological practice.

Introduction

Literature data on the weights of bones of human foetuses and newborns are extremely scarce. Apart from a scholarly interest and a motive for the universal acquisition of knowledge, few researchers have carried out measurements in this field. One explanation may be that such weight measurements are only loosely connected to the development phase of foetus in intrauterine life and, especially to the increase in body length, since the increase in weight of individual foetuses can vary considerably.

Since numerous factors (genetic, environmental, various diseases, etc.) influence the weight of a foetus in the practice of forensic medicine, the body length of a foetus or newborn is taken into consideration only when estimation of the foetal age is necessary (e.g. according to the HAASE rule, a foetus with a body length of 35 cm is is around 7 lunar months old, whereas a foetus with a body length of 50 cm is around 10 lunar months old). References are of interest in this respect.

The explanation of this practical method is that the average body length of a 10 - lunar month - old foetus varies between 48 and 53 cm, whereas its weight can vary between 2500 and 4500 g. In the given phase of development, the range of variance in the case of 10 - lunar month - old foetus is only ±3 cm on average, which means that it is no greater than 10%. This would be the case if the difference from the average body length were at least ±5 cm.

Compared to the average body weight of 3500 g, however, the range of variance of ±1000 g means approximately a difference of 30% from the average weight measurement.

If for any reason the body length can not be taken into account and it is desired to estimate the age of a foetus on the basis of the weights of its bones we consider that, the body weight can provide sufficient information. For example if incomplete fragmented limb bones are available, but the fractional part can be estimated on the basis of a comparison with the diaphysis of the limb bones as it is one - third of the full length, in such cases the weight of the bone read off from a table of weights or a graph of weights may indicate a value near to the actual age of the foetus or newborn infant. Otherwise, in similar concrete cases of scanty information, it is not possible to draw a more objective and solid conclusion as concers the age from a forensic medical examination.

Another point may be mentioned in connection with of the weight correlations of the foetal bones, i. e. on the basis of the weights of the bones, conclusions may be drawn concerning the nourishment and bodily status of a foetus and whether it was under or above the average weight. Such conclusions can be drawn from the results of several examinations. On the basis of my own examinations, I find it quite likely that there is such a correlation between the sizes (weights) of the bones and the body weights.

Material and methods

In order to solve this problem in the practice of forensic medicine, we considered it necessary to carry out weight measurements on the collection of bones of foetuses and newborns in the Department of Forensic Medicine, Albert Szent-Györgyi Medical University, Szeged.

On an automatic and calibrated scale, the weight of the diaphysis of the limb bones (humerus, radius, ulna, femur, tibia and fibula) of 79 5-10 - lunar month - old foetuses (42 male and 37 female) were weighed to milligram accuracy. Various statistical procedures were then applied in order to determine the age by considering the weight correlations of the limb bones to the body length.

Results and discussion

The weights of the limb bones are indicated in Tables 1 and 2. Linear regression does not indicate a close correlation between the weights of the bones and the body lengths. As regards the regression line calculated in this way, the points (reflecting the weights of the bones) for immature foetuses are located under the line, whereas for of mature foetuses the points are above the line. In Fig. 1, the humerus yields a correlation that is unacceptable from a forensic medical aspect. Linear regression calculations were carried out for each limb bone. This may by of scientific value, but in forensic medical practice the data cannot be used.

Table 1. Weights of limb bones of female fetuses and newborns in g.

Body length (cm)	Humerus (n=28)	Radius (n=37)	Ulna (n=36)	Femur (n=23)	Tibia (n=22)	Fibula (n=36)
20	0.09	0.01	0.02		0.06	0.01
25	0.17	0.05	0.05	0.28	0.15	0.03
27	0.27	0.08	0.09	0.29	0.19	0.06
28	0.29	0.09	0.12		0.32	0.06
29	0.21	0.05	0.06		0.18	0.04
30	0.43	0.13	0.18			0.09
31		0.12		0.64		0.12
32	0.35	0.10	0.12	0.53	0.30	0.06
32		0.13	0.17	0.64		0.09
33		0.11	0.13			0.08
33		0.12	0.15			0.08
35		0.16	0.24			0.16
35		0.17		0.84		0.18
36	0.48	0.16	0.21			0.12
36		0.15	0.11			
36		0.15	0.21			0.11
37		0.17	0.22	0.78	0.41	
40	1.04	0.34	0.48			0.31
40	1.91	0.52	0.81	3.91		0.44
40		0.25	0.34			0.18
41	0.76	0.27	0.38			0.20
41	0.83	0.22	0.34	1.43		0.18
41	1.46	0.46	0.67	2.68	1.56	0.38
42	0.85	0.28	0.41	1.64	0.97	0.25
44	0.76	0.19	0.28			0.10
45	1.23	0.41	0.62		1.45	0.38
45	2.15	0.65	0.99	4.09	2.57	0.59
46	2.67	0.87	1.24	4.97	3.18	0.64
47	1.69	0.66	0.75	3.28	1.93	0.50
48	1.86	0.62	0.80	2.18	2.02	0.48
48	2.30	0.64	1.03	4.18	2.49	0.46
50	1.87		0.89	3.53	2.18	0.53
50	1.90	0.59	0.88	3.51	2.08	0.49
50	2.02	0.64	0.90	3.51	2.23	0.53
51	1.63	0.52	0.72	2.78	1.62	0.37
52	2.28	0.72	1.14	4.23	2.54	0.59
53	1.73	0.54	0.81	2.97	1.91	0.43
53	2.19	0.64	0.96	3.82	2.24	0.58

Table 2. Weights of limb bones of male fetuses and newborns in g.

Body length (cm)	Humerus (n=32)	Radius (n=40)	Ulna (n=42)	Femur (n=13)	Tibia (n=24)	Fibula (n=41)
20	0.10	0.02	0.04	0.15	0.08	0.01
23	0.15	0.04	0.06	0.17	0.11	0.02
23	0.27	0.06	0.08		0.14	0.07
26	0.23	0.06	0.09		0.19	0.05
26	0.24	0.08	0.09	0.38	0.23	0.05
28	0.29	0.08	0.12			0.06
28		0.13	0.18	0.74		0.09
29	0.23	0.08	0.10		0.23	0.06
31	0.35	0.12	0.15		0.34	0.09
31			0.21	0.80		0.12
32			0.20	0.83		0.12
33	0.56	0.17	0.23			0.10
33		0.11	0.19			0.06
34		0.16	0.20			0.12
34		0.18	0.29			0.15
34		0.18	0.29			0.16
35	0.57	0.24	0.27			0.14
36	0.72	0.19	0.31		0.84	0.18
37	0.58	0.19	0.27			0.15
38	0.56	0.19	0.25			0.13
40	0.88	0.30	0.48			0.28
40		0.37	0.43			0.23
42	0.96	0.31	0.46		1.17	0.24
42	1.04	0.33	0.48			0.25
43	1.19	0.36	0.54		1.28	0.31
44		0.45	0.70		1.45	0.29
45	1.32	0.41	0.56			0.29
48	1.57	0.51	0.67		1.81	0.39
48	1.66	0.58	0.85		1.75	0.40
48	1.91	0.60	0.94	3.60	2.40	0.56
48	1.94	0.65	0.95		2.23	0.57
48	2.27	0.65	0.94	4.20	2.74	0.69
49	2.57	0.75	1.21			0.62
50	1.83	0.60	0.86	3.22	2.07	0.41
50	1.85	0.53	0.92	3.36	2.02	0.47
50	2.05	0.68	0.99		2.13	0.57
50		0.56	0.78			0.44
52	2.36	0.67	1.04	4.43	2.67	
53	3.28	0.93	1.29	5.68	3.61	0.87
54	1.79	0.57	0.86		2.06	0.44
54	2.41	0.76	1.13	4.83	2.95	0.68
56	2.96	1.00	1.32		3.11	0.64

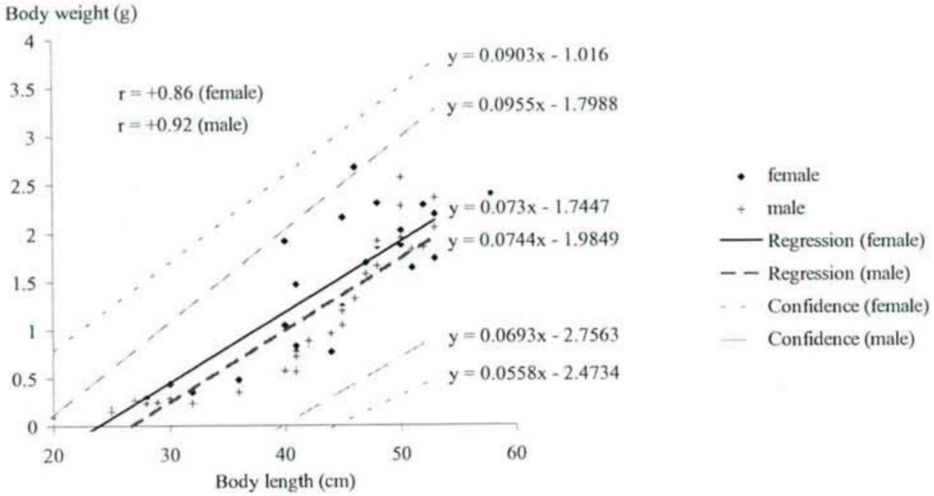

Fig. 1. Linear regression diagram for the humerus weight measurements.

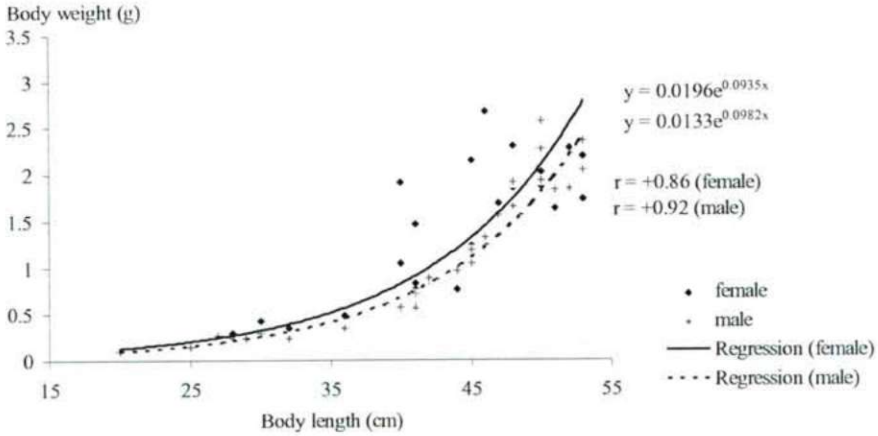

Fig. 2. Exponential regression diagram for the humerus weight measurements.

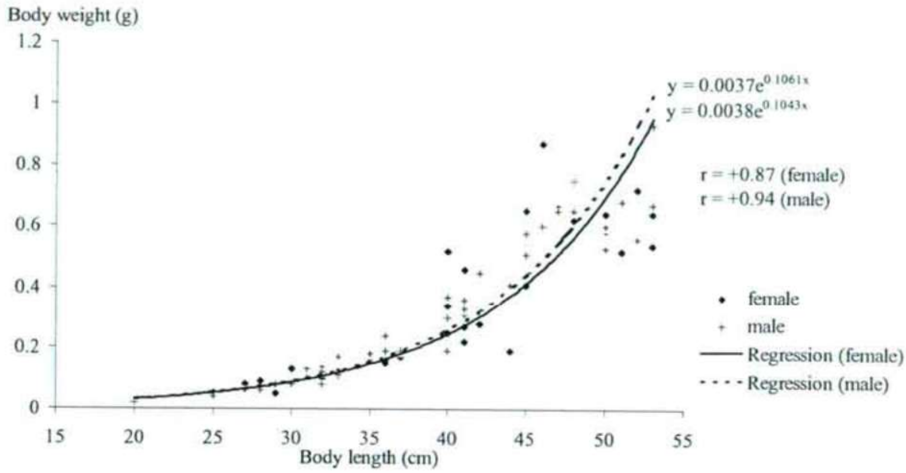

Fig. 3. Exponential regression diagram for the radius weight measurements.

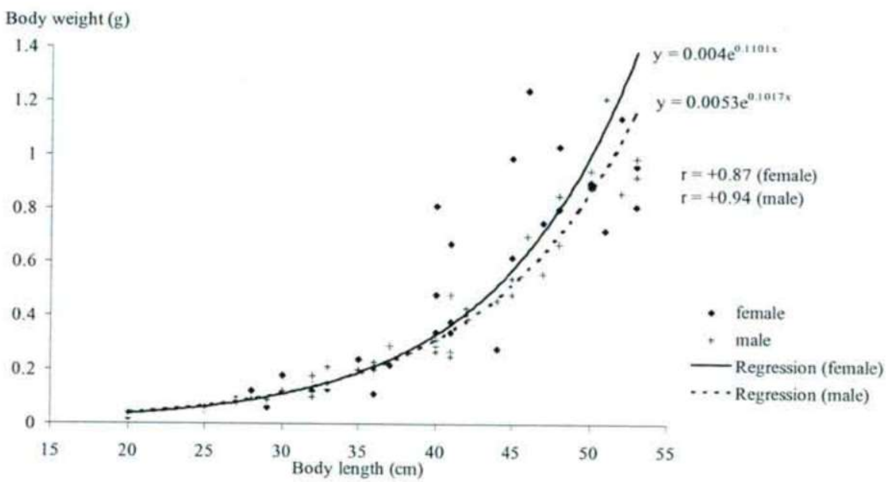

Fig. 4. Exponential regression diagram for the ulna weight measurements.

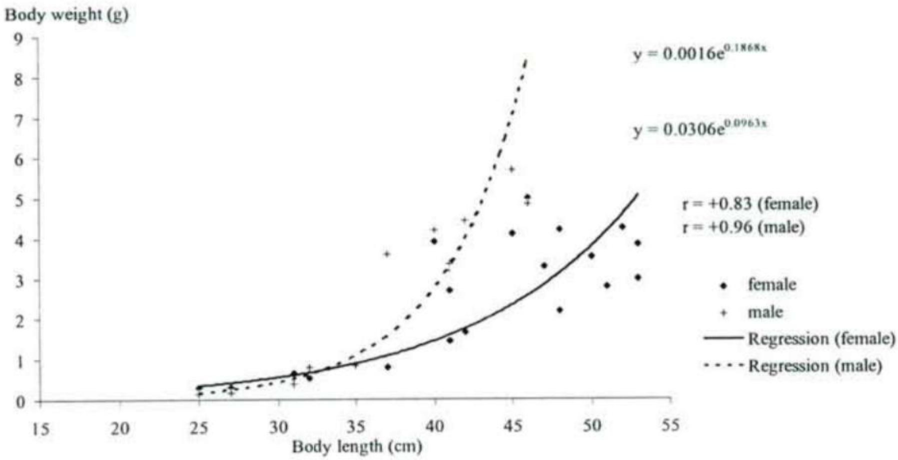

Fig. 5. Exponential regression diagram for the femur weight measurements.

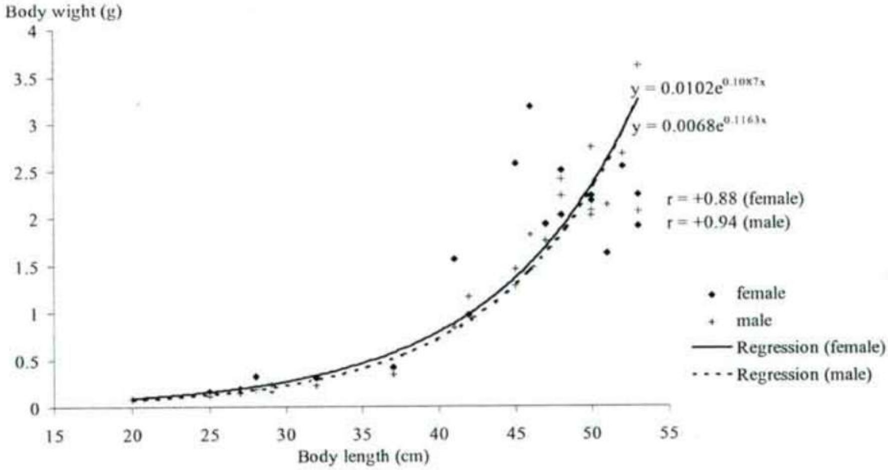

Fig. 6. Exponential regression diagram for the tibia weight measurements.

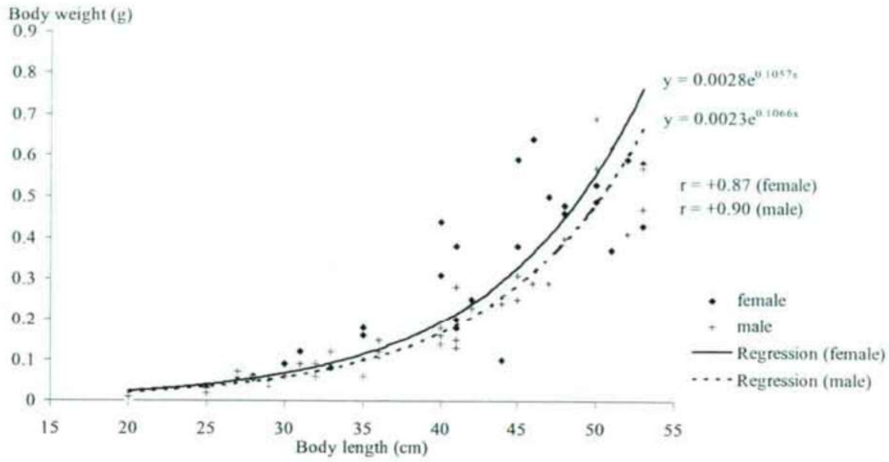

Fig. 7. Exponential regression diagram for the fibula weight measurements.

Table 3. Correlation of weight measurements of limb bones to body length.

	males	females
Humerus	+0.92	+0.86
Radius	+0.94	+0.87
Ulna	+0.94	+0.87
Femur	+0.96	+0.83
Tibia	+0.94	+0.88
Fibula	+0.90	+0.87

However the exponential regression line fits the measured points well. From the exponential regression line for the measured limb bone the body length of the foetus and its age can be read off, and therefore its age can be estimated (Figs 2-7), provided that the weights of the bones are known. In the knowledge of the regression equation, the weights of the bones can be calculated, which otherwise show a close correlation with the body length (Table 3). We have no explanation as to why this correlation is closer for boys than for girls. When the biological samples are taken into account, both examined relations exhibit a close correlation, which can be considered in forensic medical and paleoanthropological practice. Our experience so far indicates that, in a determination of the ages of foetuses and newborns, we should first take into account the lengths of the bones, whenever possible, but the weights of the limb bones can also yield good results with acceptable accuracy in the age determination of foetuses and newborns.

Literature

ADAIR, F. L. and SCAMMON, R. E. (1921): A study of the ossification centers of the wrist, knee and ankle at birth, with particular reference to the physical development and maturity of the newborn. - Amer. J. Obstet. Gynec. *2*, 35-60.

ADAMS, T. V. (1925): The estimation of foetal maturity by measurements taken after birth. - J. Obstet. Gynec. Brit. Cwlth *32*, 734-738.

ANGEL, J. L. (1980): Physical anthropology: Determining sex, age, and individual features. In: COCKBURN, A. and E. (eds): Mummies, Disease, and Ancient Cultures. - Cambridge University Press, 241-257 pp.

Araujo, J. de (1962): Maturidade fetal e ossificacao. Fetal maturity and ossification. - Pédiat. Prat. *33*, 67-74.

Balthazard, V. and Dervieux (1921): Etudes anthropologiques sur le foetus humain. - Ann. med. lég. *1*, 37-42.

BUNSEN, A. (1937): Untersuchungen zur Altersbestimmung an Knochen verbrannter Neugeborener and Frühgeburten. - Inaugural-Diss., Marburg.

CHRISTIE, A. (1949): Prevalence and distribution of ossification centers in the newborn infant. - Amer. J. Dis. Child. *77*, 355-361.

CLEMENT, J. G. and KÓSA, F. (1992): The fetal skeleton. In: CLARK, D. H. (ed.): Practical Forensic Odontology. - Wright-Buterworth-Heinemann Ltd, Oxford, 43-52 pp.

FAZEKAS, I. GY. and KÓSA, F. (1965): Die Bestimmung der Körperlänge von Feten auf Grund der Maße einiger flacher Knochen. - Dtsch. Z. ges. gerichtl. Med. *58*, 127-141.

FAZEKAS, I. GY. and KÓSA, F. (1965): Recent data and comparative studies about the body length and age of the foetus on the basis of the measurements of the clavicle and shoulderblade. - Acta med. leg. soc., (Liege) *18*, 307-325.

FAZEKAS, I. GY. and KÓSA, F. (1966): Détermination de la longeur d'embryon d'apres la dimension du radius. - Ann. méd. lég. *46*, 262-272.

FAZEKAS, I. GY. and KÓSA, F. (1966): Neuere Beiträge and vergleichende Untersuchungen zur Bestimmung der Körperlänge von Feten auf Grund der Diaphysenmaße der Extremitätenknochen. - Dtsch. Z. ges. gerichtl. Med. *58*, 142-160.

FAZEKAS, I. GY. and KÓSA, F. (1966): Donnés récentes pour la détermination de la longeur et de l'âge d'embryon humain d'apres les dimension des os du basin. - Ann. méd. lég. *46*, 334-347.

Fazekas, I. Gy. and Kósa, F. (1966): Measurements of the human fetal ribs. Data about the determination of the body length and age based on the measurements of the ribs. - Acta med. leg. soc., (Liége) *19*, 135-144.

FAZEKAS, I. GY. and KÓSA, F. (1967): Bestimmung der Körperlänge and des Alters menschlicher Feten auf Grund der Schädelbasisknochenmaße. - Dtsch. Z. ges. gerichtl. Med. *60*, 48-60.

FAZEKAS, I. GY. and KÓSA, F. (1967): Bestimmung der Körperlänge and des Alters menschlicher Feten auf Grund der Schädeldachknochenmaße. - Dtsch. Z. ges. gerichtl. Med. *60*, 149-162.

FAZEKAS, I. GY. and KÓSA, F. (1967): Bestimmung der Körperlänge and des Lebensalters menschlicher Feten auf Grund der Größenmaße der Gesichtsknochen. - Dtsch. Z. ges. gerichtl. Med. *61*, 13-28.

FAZEKAS, I. GY. and KÓSA, F. (1967): Bestimmung der Körperlänge and des Lebensalters menschlicher Feten auf Grund der ersten Hand- and ersten Fußwurzelknochenmaße, sowie der Größe des Atlas and Epistropheus-Wirbelbogens. - Dtsch. Z. ges. gerichtl. Med. *61*, 29-36.

FAZEKAS, I. GY. and KÓSA, F. (1969): Geschlechtsbestimmung bei Feten auf Grund der Hüftknochenmaße. - Arch. Kriminol. *143*, 49-57; 106-118.

FAZEKAS, I. GY. and KÓSA, F. (1978): Forensic Fetal Osteology. - Akadémiai Kiadó, Budapest.

FEHLING, H. (1876): Die Form des Beckens beim Foetus and Neugeborenen and ihre Beziehung zu der beim Erwachsenen. - Arch. Gynäk. *10*, 1.

FÖLLMER and KÖNNINGER (1951): Die Abhängigkeit der Neugeborenenlänge von der Schwangerachaftsdauer unter besonderer Berücksichtigung der Vorkriegs-, Kriegs- and Nachkriegszeit. - Arch. Gynäk. *179*, 694-708.

GUTHMANN, H. and KNÖSS, S. (1939): Mit welcher Sicherheit läßt sich aus der Kindergröße die Tragzeit ermitteln? - Zbl. Gynäk., *63*, 2636-2655.

HOSEMANN, H. (1949): Schwangerschaftsdauer and Neugeborenengewicht. - Arch. Gynäk., *176*, 109-123.

HUNGER, H. and LEOPOLD, D. (1978): Identifikation. - Johann Ambrosius Barth, Leipzig.

ISCAN, M. Y. and KENNEDY, K. A. R. (1989): Reconstruction of life from the skeleton. - Alan R Liss, Inc., New York.

KEY-ABERG, A. (1917): Über die Größenverhältnisse gewisser Skeletteile menschlicher Embryonen in verschiedener Entwicklung. - Vjschr. gerichtl. Med. 3. F. *53*, 206-211.

KÓSA, F. (1969): Körperlänge and Lebensalterbestimmung von Feten auf Grund der Knochenmaße. - Kandidátusi értekezés, Szeged.

KÓSA, F. and FAZEKAS, I. GY. (1972): Les possibilités de la détermination de l'âge foetal d'apres les étapes évolutives (transformations) des os de la voute du crâne. - Méd. Lég. et Dommage Corp. *5*, 339-346.

KÓSA, F. and FAZEKAS, I. GY. (1973): Les possibilités de la détermination de l'âge foetal d'apres l'évolution morphologique des os de la base du crâne. - Méd. Lég. et Dommage Corp. *6*, 250-257.

KÓSA, F. (1972): Morphologische Untersuchung fetaler Schulter- and Beckenknochen vom gerichtsmedizinischen Gesichtspunkt. - Zacchia *47*, 445-456.

KÓSA, F. (1973): Feststellung der Körperlänge and des Lebensalters von Feten auf Grund der Größenmaße der Gehörknöchelchen. - Z. Rechtsmedizin *71*, 264-269.

KÓSA, F. (1973): Regressions- and Korrelationsuntersuchungen fetaler Schädelbasisknochenmaße mit Hinsicht auf die Geschlechtsunterschiede. - Gegenbaurs morph. Jb. *119*, 336-345.

Kósa, F. (1973): Die Größenmaße der Gehörknöchelchen menschlicher Feten. - Gegenbaurs morph. Jb. 119, 712-719.

KÓSA, F. (1974): Die populationsgenetische Beziehung der Körperlängenbestimmung auf Grund der Extremitätenknochenmaße von Feten. - Kriminalistik u. forens. Wiss. *17*, 59-74.

KÓSA, F. (1978): Identifikation des Feten durch Skelettuntersuchungen. In: HUNGER, H. and LEOPOLD, D. (eds): Identifikation. - Barth, Leipzig.

KÓSA F. (1989): Age estimation from the fetal skeleton. In: Iscan, M.Y. (Ed.): Age Markers in the Human Skeleton. - Charles C.Thomas Publischer, Springfield, Illinois, 21-54 pp.

KRINGS, U. (1960): Die Diaphysenlängen der großen Röhrenknochen des Feten and ihre Beziehung zur Körpergröße. - Inaugural-Diss. Hamburg.

KROGMAN, W. M. (1949): The human skeleton in legal medicine. Lewison Symposium. - Lipincott, London-Philadalphia-Montreal.

KROGMAN, W. M. and ISCAN, M. Y. (1986): The human skeleton in forensic medicine. - Charles C. Thomas, Springfield, Illinois.

LAMBERTZ, J. (1900): Die Entwicklung des menschlichen Knochengerüstes während des fötalen Lebens. - Fortschr. Röntgenstr. *1*, 1-81.

LANGER, K. (1872): Wachstum des menschlichen Skelettes. - Denkschr. Ksl. Akad. Wien, Math. Naturwiss. Kl. *13*, 1-106.

MALL, F. P. (1906): Ossification centres in human embryos less than one handred days old. - Amer. J. Anat. 5, 433-458.

MALL, F. P. (1910): Determination of the age of human embryos and fetuses. In: KEIBEL, F. and MALL, F. (eds): Manual of human embryology *1*, 180-201.

MARTIN, R. and SALLER, K. (1959): Lehrbuch der Anthropologie. - Fischer, Stuttgart, 2. Bd.

MULLER, M. (1938): La calcination du foetus en médicine légale. - Verhandlungsbericht. I. Internationaler Kongreß für gerichtliche and soziale Medizin. Bonn 483 pp.

NAGAMORI, H., EBE, M. SASAKI, M. and KURODA, S. (1965): Medicolegal studies on the fetus and the infant. II. Value of the length of tabular skeletons in the estimation of the age of the fetus. - J. Jap. Leg. Med. *19*, 422 - 430.

NOBACK, C. R. (1944): Developmental anatomy of human skeleton during embryonic fetal and circumnatal periods. - Anat. Rec. *88*, 91-125.

OLIVIER, G. and PINEAU, H. (1960): Nouvelle détermination de la taille foetale d'apres les longueurs diaphysaires des os longs. - Ann. méd. lég. *40*, 141-144.

PETERSOHN, F. and KÖHLER, J. (1964): Die Bedeutung der Veränderungen an fetalen Röhrenknochen nach Trocknung and Hitzeeinwirkung für die forensische Begutachtung der Fruchtgröße. - Arch. Kriminol. 134, 143-162.

ROBB, R. and CLARK, J. (1934): Growth of bone shafts in human fetus. - Proc. Soc. Exp. Biol. Med. N.Y. 31, 634-636.

ROBECCHI, E. (1934): La maturita fetale. Valore clinico e medico-legale dei nuclei d'ossificatione dei ginocchio. - Boll. Soc. piemont. diostetr. ginec. *2*, 253-276.

SAETTELE, R. (1951): Körpergrößenbestimmung menschlicher Früchte an Hand der Längenmaße einzelner Skeletteile oder deren Diaphysen. - Dtsch. Z. ges. gerichtl. Med. *40*, 567 - 577.

SCHRADER, G. (1938): Untersuchungen zur Altersbestimmung an Knochen verbrannter Neugeborener and Frühgeburten. - Dtsch. Z. ges. gerichtl. Med. *29*, 152-158.

SIEBERT, E. 0. (1941): Die Altersbestimmung menschlicher Früchte and ihre gerichtsmedizinische Anwendung. - Dtsch. Z. ges. gerichtl. Med. *34*, 471-533.

SWOBODA, W. (1956): Das Skelett des Kindes. - Thieme, Stuttgart 10-32 pp.

SZÁSZ, B. (1938): Knochendimensionen des Fetus. - I. Intern. Kongr. gerichtl. soz. Med. Bonn 518 pp.

TEKATA, G. (1922): On the value of bones as diagnostic material of fetal age. - Folia anat. Jap. *1*, 63 - 68.

THOMSON, A. M. (1951): Human fetal growth. - Brit. J. Nutr. *5*, 158-166.

TOLDT, C. (1882): Die Knochen in gerichtsmedizinischer Beziehung. In: Maschkas Handbuch der gerichtlichen Medizin. - Laupp'sche Buchhandlung, Tübingen *3*, 483 pp.

UBERLAKER, D. H. (1989): Human sketal remains. (second ed). - Smithsonian Institution, Taraxacum Washington.

WICHMANN, D. (1950): Die Wahrscheinlichkeitsberechnung bei der Vaterschaftsbegutachtung. - Arch. Gynäk. *177*, 261-269.

ZANGEMEISTER, W. (1912): Tafeln zur Altersbestimmung menschlicher Früchte. - Enke, Stuttgart.

ACTA BIOL. SZEGED. 42, pp. 235-240 (1997)

SOCIAL FACTORS AND PHYSICAL GROWTH OF SCHOOL CHILDREN IN JENA

K. KROMEYER-HAUSCHILD and U. JAEGER

Institute of Human Genetics and Anthropology, Friedrich-Schiller-University Jena, Germany

(Received: January 7, 1997)

Abstract

The relation between social environment and growth was studied on bases of data on Jena school children examined in 1995. The number of children living in the household, and the professional status of the father and mother were analysed in their relationship to height, the body mass index (BMI) and the sum of the skinfolds.

Only a minor part of the variation in height is explained by the social factors. A statistically significant association was found between the professional status of the parents and the BMI and the sum of the skinfolds. Children of parents with a higher educational level were slimmer than children of parents with a lower status.

Key words: body height, skinfold thickness, body mass index, socio-economic factors and growth.

Introduction

Many publications have indicated (e.g. GOLDSTEIN, 1971; WELON and BIELICKI, 1973; WALTER et al., 1975; JOUBERT, 1982; MÜLLER-KÖNIG, 1983; JOHNSTON et al., 1987; LASKER, 1989) that, while there may be genetic differences between individuals, the variability in physical growth of children to a large degree reflects differences in the quality of their environments. Physical growth is a powerful indicator of the social and economic environment of human populations. The factors most frequently investigated include social-cultural parameters (ethnicity, and rural-urban differences), biological background (parents' height, birth weight, and birth length) and socio-economic factors (number of children in the household, and educational and professional levels of the parents).

In general, it has been found that children of a higher socio-economic status are taller than children of a lower status. While socio-economic differences are larger in countries with a low standard of living, a trend toward equal living conditions in different socio-economic classes has been found in developed countries (BRUNDTLAND, 1980; MEREDITH, 1984; CERNERUD and LINDGREN, 1991; etc.). In these countries, the differences in growth between social classes have decreased or levelled out. This obliteration of social gradients is predominantly observed in those countries where there has been a general improvement in the living standards.

The aim of the present report is to analyse the relationships between the social characteristics of children from Jena (Germany) and their growth. The process of the unification of Germany in 1989 brought about important changes in the social, cultural and individual environments for the people, especially in the previously socialist region. The present study analyses only those socio-economic factors which were mainly established under socialist conditions. In further studies it will be establish whether the changes in the structure of the community have an effect on growth.

Material and methods

The analyses reported in this paper are based on data on Jena school children aged between 7 and 14 years, were examined in 1995. The present study is restricted to an analysis of height the and the sum of the skinfolds (sum of skinfolds = triceps + subscapula + coxa). The body mass index (BMI), calculated as body weight (kg) divided by stature (m) squared, was used to examine the weight-to-height relationships. Height and weight were measured as described by MARTIN and SALLER (1957) with standard anthropometric instruments. Height was measured to the nearest 0.1 cm on the scale. The children were weighed wearing only underpants. Weight was recorded to the last complete 500 g.

The technique of skinfold measurements was described in detail by TANNER and WHITEHOUSE (1975). In accordance with these authors, the skinfolds were measured on the right side of the body with GPM callipers.

Social data on the families of the children were obtained by means of a questionnaire, which had to be filled out by the parents. The data on 1032 children (498 boys and 534 girls) will be considered in this study. The number of children in the household, the professional status of the father and the professional status of the mother are analysed in their relations to the anthropometric parameters mentioned above.

The professional status of the parents was categorised as either skilled or highly qualified (university degree or high school diploma).

In the analyses, the anthropometric parameters were used in standard deviation units (SDS), in order to remove the effect of age. The SDS expresses the difference between a measurement for a child and the mean for the group of the same age and sex, divided by the standard deviation for that group. Since the distribution of weight and the sum of the skinfolds displayed statistically significant departures from normality (the KOLMOGOROFF-SMIRNOFF test was used to verify the assumption of normality; $p<0.05$), before calculation of the appropriate SDS for a child the measurements (x) were transformed ($1/\sqrt{x}$) to give an approximate Gaussian distribution in each age group.

The relationship between the height and the social variables was estimated by multiple regression analysis. As the distributions of the SDSs of the BMI and the sum of the skinfolds are skewed, the KRUSKAL-WALLIS test or the MANN-WHITNEY U test was used to analyse the relationship between these parameters and the social factors.

Results

Table 1 shows the frequency distribution of the social factors by sex. In the distribution of these parameters, no significant sex differences are observed (χ^2-test; $p<0.05$). For both sexes, there are more highly qualified mothers.

The multiple regression analysis shows that the social factors were not significantly associated with height in either sex (boys: $R^2=0.002$, $p=0.870$; girls:

R^2=0.013, p=0.135). Nevertheless, the mean values of the height standard deviation scores by sex and social group show a tendency to social gradients for all factors (Fig. 1). This tendency is more pronounced for girls than for boys. For both sexes, children from families with three or more sibs are on average shorter than those from families with less sibs. A relationship is also found between the height and the professional status of the parents; a higher professional level is paralleled by an increase in body height (except for the professional status of the father among boys).

Table 1. Frequency distribution of social variables according to sex.

Number of children	1 child		2 children		3 and more children		Total	
Boys	128	25.8%	279	56.3%	89	17.9%	496	48.3%
Girls	134	25.2%	297	55.9%	100	18.8%	531	51.7%
Total	265	25.5%	576	56.1%	189	18.4%	1027	
χ^2 = 0.147 (d.f. = 2), p = 0.929								

Profession of father	skilled workers		highly qualified		Total	
Boys	259	60.8%	167	39.2%	426	48.3%
Girls	265	58.1%	191	41.9%	456	51.7%
Total	524	59.4%	358	40.6%	882	
χ^2 = 0.658 (d.f. =1), p = 0.417						

Profession of mother	skilled workers		highly qualified		Total	
Boys	207	44.8%	255	55.2%	462	47.6%
Girls	241	47.3%	268	52.7%	509	52.4%
Total	448	46.1%	523	53.9%	971	
χ^2 = 0.630 (d.f. =1), p = 0.427						

Figure 2 demonstrates the relationship between the BMI and the social parameters. The children of highly qualified parents have on average a lower BMI than the other children. The BMI values differ significantly across the professional groups.

Boys of larger sibships are on average lighter (lower BMI) than those of smaller sibships. The same is observed for girls (except for girls from two-child families). These differences are not significant.

Similar results were found as concerns the relation between the sum of the skinfolds and the social factors (Fig. 3). With an increasing number of children in the family, the sum of the skinfolds decreases. These differences, however, are statistically insignificant. The sum of the skinfolds is lower for children of parents with a higher professional level. These differences are statistically significant.

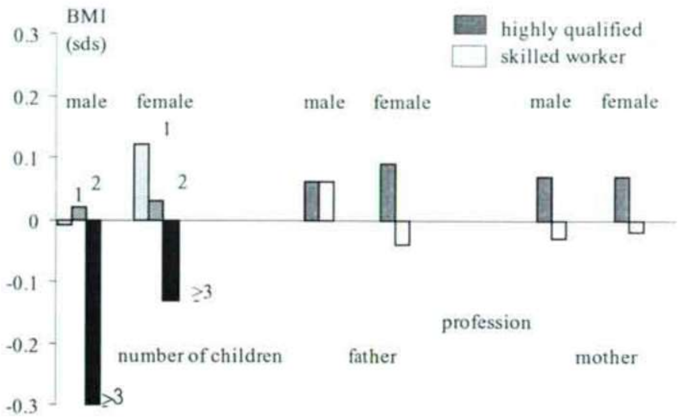

Fig. 1. Mean values of body height standard deviation scores in different social groups.

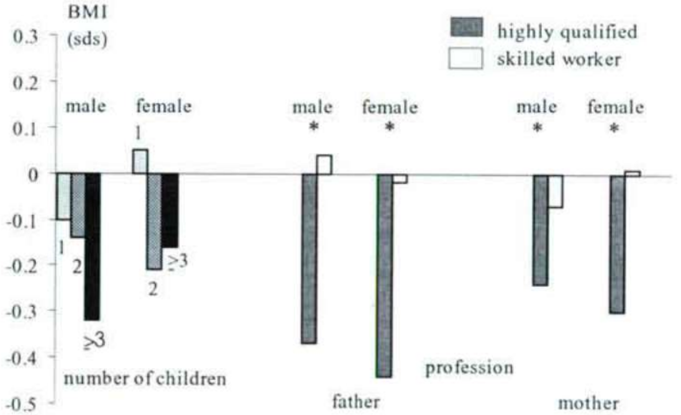

Fig. 2. Mean values of the body mass index standard deviation scores in different social groups.

Discussion

In this study, only a minor part of the variation in height is explained by the social factors. We found only a tendency to social gradients in height for all factors. Children of "higher" socio-economic status were taller than children of "lower" status. These differences are relatively small.

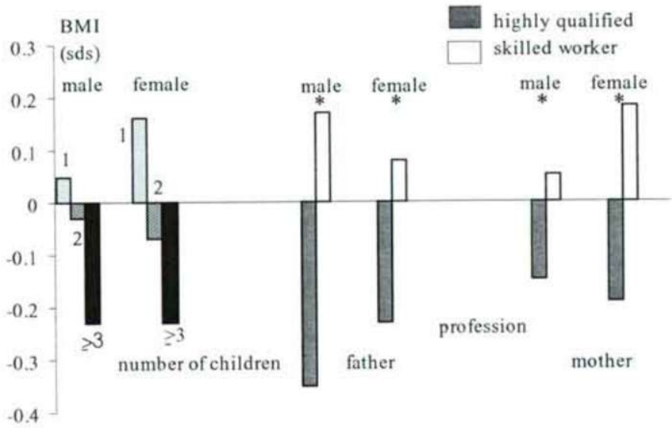

Fig. 3. Mean values of the sum of skinfolds standard deviation scores in different social groups.

Our observations of the limited effect of the social environment on height are confirmed by other German researchers: WALTER et al. (1975) showed this absence of socio-economic differences for height and weight on children aged 6 to 11 years from Western Germany. In East Germany, the previous GDR, only a few earlier studies (MARCUSSON, 1961; OEHMISCH, 1970; REISSIG, 1980) referred to social differences. For Jena children, JAEGER (1983) found differences in growth in relation to the birth order in 1975, but only small differences between pupils from the town or from the countryside. In 1975, SÄLZLER (1975) reported a diminishing difference in the growth of children in relation to the profession of the parents. These observations are in agreement with those obtained in other European populations (e.g. SMITH et al., 1980; LINDGREN, 1976; RONA and CHINN, 1986). It is presumed that this is a result of the improvement in the general living conditions (e.g. increasing incomes, reduction in the number of children per family, and improvements in hygienic conditions), which have especially favoured the situation of the lower social groups.

Our sample revealed a significant association between the social groups and the weight-to-height relationship and the skinfolds. In general, it was found that children of parents with a higher educational level are slimmer than children of parents with a lower status. In contrast, we found that children of larger sibships were on average slimmer than those of smaller sibships. These results are consistent with those of other studies: for children born in Sweden in 1967, LINDGREN (1994) found no height differences between different socio-economic classes, but the working-class children, and especially the girls, were still considerably heavier. The tendency to increasing slenderness (decreasing weight for height and decreasing skinfolds) in the higher social groups may be affected by differences in food consumption. Our results indicates that the professional status of the parents is obviously a principal determinant of the lifestyle of the families, especially as concerns eating and drinking habits. In the lower social groups, no nutritional deficits are present under the existing conditions, and the nutritional condition of the families is a question of the educational level.

Apart from the more economic factors such as family size, education, housing, etc. we have to consider more details, including the quality of children's care, in further studies.

References

BRUNDTLAND, G. H. (1980): Height, weight and menarcheal age of Oslo school children during the last 60 years. - Ann. Hum. Biol. *7*, 307-322.

CERNERUD, L. and LINDGREN, G. W. (1991): Secular changes in height and weight of Stockholm schoolchildren born in 1933, 1943, 1953 and 1963. - Ann. Hum. Biol. *18*, 497-505.

GOLDSTEIN, H. (1971): Factors influencing the height of seven year old children - Results from the National Child Development Study. - Hum. Biol. *43*, 92 - 111.

JAEGER, U. (1983): Ergebnisse anthropologischer Untersuchungen unter Berücksichtigung des Einflusses der säkularen Akzeleration und ausgewählter sozialer Faktoren auf das Wachstum und die Entwicklung von Kindern und Jugendlichen aus dem Jenaer Raum. - Biologische Rundschau *21*, 293- 307.

JOHNSTON, F. E., SETHA, M. L., DE BAESSA, Y. and MACVEAN, R. B. (1987): Interaction of nutritional and socioeconomic status as determinants of cognitive development in disadvantaged urban Guatemalan children. - Am. J. Phys. Anthropol. *73*, 501-506.

JOUBERT, K. (1982): Distribution of the new-born with low birthweight by some demographic characteristics on the basis of national data on live-birth in 1975. - Hum. Biol. *12*, 187-197.

LASKER, G. W. (1989): Effects of social class differences and social morbility on growth in height, weight and body mass index in a British cohort. - Ann. Hum. Biol. *16*, 1-8.

LINDGREN, G. (1976): Height, weight and menarche in Swedish urban school children in relation to socio-economic and regional factors. - Ann. Hum. Biol. *3*, 501-528.

LINDGREN, G. (1994): Aspects of research on socioeconomic conditions and growth based on Swedish data. In: Auxology '94. - Humanbiol. Budapest. *25*, 123-133.

MARCUSSON, H. (1961): Das Wachstum von Kindern und Jugendlichen in der Deutschen Demokratischen Republik. - Akademie-Verlag, Berlin.

MARTIN, R. and SALLER, K. (1957): Lehrbuch der Anthropologie, Bd. 1. 3.Aufl., Stuttgart, Fischer.

MEREDITH, H. V. (1984): Body size of infants and children around the world in relation to socioeconomic status. - Advances in Child Development and Behaviour *18*, 81-145.

MÜLLER-KÖNIG, T. (1983): Das Wachstum von Körperhöhe und Gewicht bei Knaben und Mädchen im Schulalter mit besonderer Berücksichtigung der sozialen Schichtung. - Z. Morph. Anthropol. *74*, 199-224.

OEHMISCH, W. (1970): Die Entwicklung der Körpermaße bei Kindern und Jugendlichen in der Deutschen Demokratischen Republik. Ergebnisse einer repräsentativen Untersuchung in den Jahren 1967/68. - Akademie für Arztliche Fortbildung, Berlin.

REISSIG, M. (1980): Zur körperlichen Entwicklung in der Pubeszenz. - Längsschnittuntersuchung an Leipziger Schülern vom 12. bis 16. Lebensjahr unter Berücksichtigung des Akzekerationsaspektes. - Habil-Schrift, Leipzig.

RONA, R. J. and CHINN, S. (1986): National Study of Health and Growth: social and biological factors associated with height of children from ethnic groups living in England. - Ann. Hum. Biol. *13*, 453-471.

SÄLZLER, A. (1975): Die Akzeleration - ein gesellschaftlich und biologisch gesteuerter Prozess. - Anthropol. Közlem. *19*, 195-200.

SMITH, A. M., CHINN, S. and RONA R. J. (1980): Social factors and height gain of primary schoolchildren in England and Scotland. - Ann. Hum. Biol. *7*, 115-124.

TANNER, J. M. and WHITEHOUSE, R. H. (1975): Revised standards for triceps and symptoms in primary school. - Archives of Disease in Childhood *59*, 142-145.

WALTER, H., FRITZ, M. and WELKER, A. (1975): Untersuchungen zur sozialen Verteilung von Körperhöhe und Körpergewicht. - Z. Morph. Anthrop. *67*, 6-18.

WELON, Z. and BIELICKI, T. (1973): The adolescent growth spurt and the critical body weight hypothesis. - Materialy i Prace Antropologiczne *86*, 25-33.

ACTA BIOL. SZEGED. 42, pp. 241-243 (1997)

BODY COMPOSITION AND BLOOD PRESSURE OF MEDICAL STUDENTS

E. LEFFELHOLC[1] and É. B. BODZSÁR[2]

[1]*Institute of Hygiene and Epidemiology, Semmelweis University Medical School, Budapest;*
[2]*Department of Biological Anthropology, Eötvös Loránd University, H-1088 Budapest, Puskin u. 3., Hungary*

(Received: January 5, 1997)

Abstract

The purpose of the present study was to provide data relating to the question of whether or not a higher relative fat content is associated with a tendency for higher blood pressure to develop. Data were measured on medical students (158 females and 180 males, aged 24 yrs).

Body fat content and systolic and diastolic blood pressure were determined. Intergroup differences were analysed by the t-test on independent samples.

Both the systolic and the diastolic blood pressure means were significantly higher in the students with a higher relative body fat content, and the relative body fat content was significantly higher in the male and female subgroups displaying higher mean systolic and diastolic blood pressures.

The correlations between body fat content and blood pressure for the overall material confirm the positive relationship postulated, though the coefficients were moderate in both genders.

Key words: students, blood pressure; body fat content.

Introduction

In comparison with university students in general medical students have been found to be both heavier and markedly fatter (TILL and GYENIS, 1973; GYENIS and TILL, 1981; BODZSÁR et al., 1987). On the other hand, the blood pressure of medical students was reported not to different from that of their peer population.

In view of such observations, the purpose of the present study was to provide data on the question of whether or not a higher relative fat content is associated with a tendency for a higher blood pressure to develop among medical students.

For a better insight, the present study compared medical students in respect of:

1. the systolic and diastolic blood pressure means, by creating three subgroups of the material on the basis of fat content, the grouping limits being mean fat% plus and minus one S.D.; and

2. the body fat content means, by creating three subgroups on the basis of systolic and diastolic blood pressure, the grouping limits again being plus and minus one S.D. from the mean pressures.

Only comparisons between the respective farthest subgroups are reported here.

Material and methods

The subjects were medical students attending the 10th semester at Semmelweis Medical University in Budapest (N = 158 females, aged $\overline{x}$ = 24± 0.18 yrs and N = 180 males, aged $\overline{x}$ = 24 ± 0.37 yrs).

Students with an impaired health status were not included.

Relative body fat was estimated by using the formulas of DURNIN and RAHAMAN (1967) and of SIRI (1956). Systolic and diastolic blood pressure were determined by the auscultation method. Intergroup differences were analysed by the t-test for independent samples at the 5% level of random error.

Results and conclusions

All intergender differences in examined characters were significant (Table 1). The female students had a higher body fat content and a lower blood pressure than the male age-mates.

Table 1. Descriptive statistics of the studied parameters

VARIABLE	BOYS		GIRLS	
	MEAN	S.D.	MEAN	S.D.
BF%	22.0	4.8	30.7	4.4
TBF/FFM[%]	28.7	8.2	45.0	9.3
S.PR.[mmHg]	122.3	13.8	111.0	10.3
D.PR.[mmHg]	80.6	7.8	75.2	7.8

Abbreviations: B F % = body fat percentages; TBF= total body fat [kg]; FFM= fat-free mass[kg]; S.PR.= systolic pressure; D.PR.= diastolic pressure.
Note: All intergender differences were significant at the 5% level.

Statistically, both the systolic and diastolic blood pressure means were significantly higher in the students with a higher relative body fat content. Physiologically, the mean blood pressure was higher only in the males in the high body fat subgroup, while all female means were slightly hypotensive (Table 2).

Table 2. Body fat percentages for the low and high blood pressure subgruoups.

SUBGROUPS	BOYS		GIRLS	
	MEAN	S.D.	MEAN	S.D.
SYSTOLIC PRESSURE				
LOW	18.7	3.2	28.2	4.8
HIGH	25.9	4.6	32.2	4.7
DIASTOLIC PRESSURE				
LOW	19.7	3.6	26.5	3.6
HIGH	24.2	5.0	31.6	4.5

Conversely, the mean relative body fat content was statistically significantly higher in the male and female subgroups displaying higher mean systolic and diastolic blood pressures (Table 3). Accordingly, the relationship between elevated blood pressure and body fat content appears to hold only for intragender comparisons.

Table 3. Blood pressures for the low and high body fat subgroups.

	SYSTOLIC MEAN S.D.	DIASTOLIC MEAN S.D.	SYSTOLIC MEAN S.D.	DIASTOLIC MEAN S.D.
	BOYS		GIRLS	
BODY FAT%				
LOW	118.7 12.8	79.5 8.6	106.2 8.7	69.6 8.6
HIGH	130.4 13.7	87.1 8.6	112.0 9.8	76.0 5.9
BODY FAT/FATFREE MASS%				
LOW	118.3 13.6	78.4 8.8	106.2 8.7	69.6 8.6
HIGH	130.4 13.7	87.1 8.6	112.3 9.7	76.1 5.9

Linear correlations between body fat content and blood pressure for the total material confirm the positive relationship postulated, though the coefficients were moderate in both genders (Table 4).

Table 4. Linear correlation coefficient between body fat% and blood pressure.

VARIABLE	TBF%	TBF/FFM%	SYSTOLIC	DIASTOLIC
TBF%	-	.99	.29	.30
TBF/FFM%	.99	-	.31	.34
SYSTOLIC	.27	.27	-	.68
DIASTOLIC	.32	.30	.77	-

References

BODZSÁR, É., LEFFELHOLC, E., and VEDRES, I. (1987): Egyetemi hallgatók szomatopszichés státusza (The somato-psychic condition of university students in Hungary). - Tudományos Ülésen Elhangzott Előadások, Győr, 28-37 pp.

DURNIN, Y. V. G. A. and RAHAMAN, M. N. (1967): The assesment of the amount of fat in the human body from measurements of skinfold thickness. - Brit. J. Nutr. *21*, 681.

GYENIS, GY. and TILL, G. (1981): Magyar egyetemi hallgatók testmagassága és testsúlya. - Anthrop. Közl. *25*, 17-23.

SIRI, W. E. (1956): Body composition from fluid spaces and density. - MS UCRL 3349. Donner Lab., University of California.

TILL, G. and GYENIS, GY. (1973): Megfigyelések a vérnyomás és a testmagasság, illetve a testsúly összefüggéséről a Budapesti Műszaki Egyetem I. éves hallgatóinak vizsgálata alapján. - Anthrop. Közl. *17*, 1-2, 83-96.

ACTA BIOL. SZEGED. 42, pp. 245-249 (1997)

THE ANGLE OF LANDZERT (SPHENOIDAL ANGLE) AS A POSSIBLE NEW AGE ESTIMATOR IN FORENSIC ANTHROPOLOGY

G. LEONETTI[1,2] and O. DUTOUR[2]

[1]*Service de Médecine Légale, Université de la Méditerranée, Faculté de Médecine, 27, Bd Jean Moulin, 13385 Marseille Cedex 5, France;*

[2]*Laboratoire d'Anthropologie Biologique, Faculté de Médecine de Marseille - UMR 6578 CNRS/Université de la Méditerranée, 13385 Marseille Cedex 5, France.*

(Received: January 10, 1997)

Abstract

The general morphology of the human cranial base is mainly characterized by the angulations between the three cranial fossae. Numerous angles have been studied in comparative anatomy, ontogenetic and phylogenetic studies and human paleontology. However, the variability of these angles is not well defined in modern humans and consequently no forensic applications have been described to date. In this work, a study was made of the variability of the main angle of cranial flexion (sphenoidal angle) on a sample of 330 human skulls of known sex, ethnicity and age from the HAMAN-TODD anatomic collection (Cleveland Museum of Natural History, Ohio, USA). The study suggested that the age is the most important factor in the variation of this angle. This first result permits a consideration of its possible application in forensic anthropology.

Key words: forensic anthropology, age determination, aging, skull base, main angle of cranial flexion, sphenoidal angle.

Introduction

The morphology of the human cranial base is mainly characterized by the angulations between the three cranial fossae, clearly evidenced on mesial sagittal sectioned crania. Study of the angles of the skull base is of interest in comparative anatomy (CAMERON, 1927; LAITMAN et al., 1978), in ontogeny (BOLK, 1909), in phylogeny (AIELLO and DEAN, 1990) and in the speech production abilities of the fossil hominids (LIEBERMAN, 1984). Changes induced in the cranial base angles by artificial cranial deformation have been also reported by several authors (BJORK, 1955; MOSS, 1958; ANTON, 1989).

However, the parameters of variability of the cranial base angles are poorly documented in modern *Homo sapiens*. Magnetic resonance imaging recently evidenced age-related changes in the bone marrow of the normal clivus (KIMURA et al., 1990; OYAR et al., 1996). Our interest in the dynamic pattern in human skeletal biology led us to the question of whether morphological changes in the human skull base could also be detected by gross examination and whether applications in forensic science can be deduced.

In order to establish the influence of age, sex and ethnicity on the general variability of the human skull base, we decided to study the variability of the main angle of the cranial base, constituted by the planes of the anterior and middle cranial fossae (sphenoidal). This angle has been described as the main angle of cranial flexion (CAMERON, 1927).

Materials and methods

This study was performed on a randomized sample of 330 human skulls of known age, sex and ethnicity (African and European origins) sectioned in the mesial sagittal plane, from the HAMAN-TODD anatomic collection (Department of Physical Anthropology, Cleveland Museum of Natural History, Ohio, USA). The sample was composed of 183 males (88 "whites", 95 "blacks") and 147 females (74 "whites", 73 "blacks"). No statistical differences appeared in the distribution of this sample, as tested by the chi-squared test. The age range was from 17 to 90 years. Analysis of the 5-year categories revealed a moderate surplus in the middle categories (35-55 years) and a moderate shortage in the oldest and youngest categories (Fig. 1), which corresponds to the structure of the entire collection. It should be noted that this sample includes 30 individuals younger than 25 years.

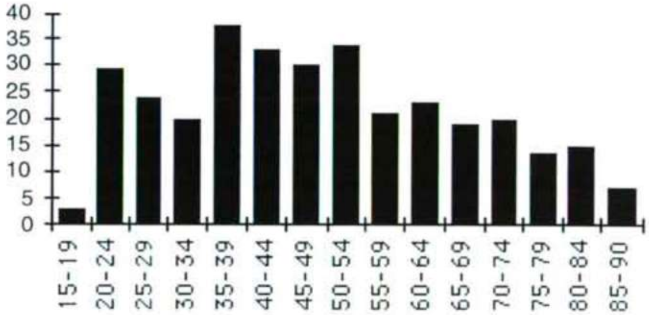

Fig. 1. Age distribution of the analysed sample (5-year categories).

After separation of the two half-skulls, the angle was measured directly with a goniometer on the left side. The individual data (age, sex and ethnicity) were unknown to the person conducting the measurements (blind test). The angle constituted by the anterior fossa plane and the middle fossa plane was measured. At the middle of the anterior fossa, the cribriform plate of the ethmoid bone is located between the left and right orbital processes of the frontal bone; these form the roof of the orbital cavities.The anterior plane is known as the planum sphenoidale. The crista galli is located at the front of the cribriform plate. The plane of the middle cranial fossa is represented by the planum of the clivus: this slope is formed by the posterior part of the dorsum sellae, in continuation with the superior aspect of the basilar process of the occipital bone.

Several techniques are used to measure the sphenoidal angle (OLIVIER, 1965): that of WELCKER using the nasion, the ephippion and the basion; that proposed by CAMERON (1925), using the nasion, the pituitary and the basion; measurement of the nasion-prosphenion-basion angle; and the method of LANDZERT, which measures the angle constituted by the clivus and sphenoidale plana. We chose the LANDZERT method, as it is the simplest and most accurate. However, according to OLIVIER (1965), the results are similar whatever the technique used.

According to the LANDZERT technique, we measured the angle as follows: one branch is placed on the clivus plate, from the basion to the pituitary, while the other one is placed on the planum sphenoidale. The vertex of the angle often corresponds to the posterior part of the sella turcica. The planum sphenoidale more often reaches the nasion, but we did not take this into account in the measurement.

The 30 individuals of the sample who were younger than 25 years old were analysed separately: before this age, the growing process is not ended and the fusion of the sphenooccipital synchondrosis is not complete. This fact could induce differences in the mean values of the sphenoidal angle. The present paper will mainly concentrate on the results obtained in the adults. The results were analysed by classical statistical tests (mean, standard deviation, standard error of mean, correlation, regression, t-test and chi-squared test).

Results and discussion

The overall variation in the sphenoidal angle in the sample is from 85 to 155°. Analysis of the variability from 25 to 85 years, in 5-year classes, showed a progressive decrease in the mean value with the age (r2: 0.882) and a "stepwise" aspect of this decreasing phenomenon, recognizable in 4 main stages (Fig. 2, Table 1).

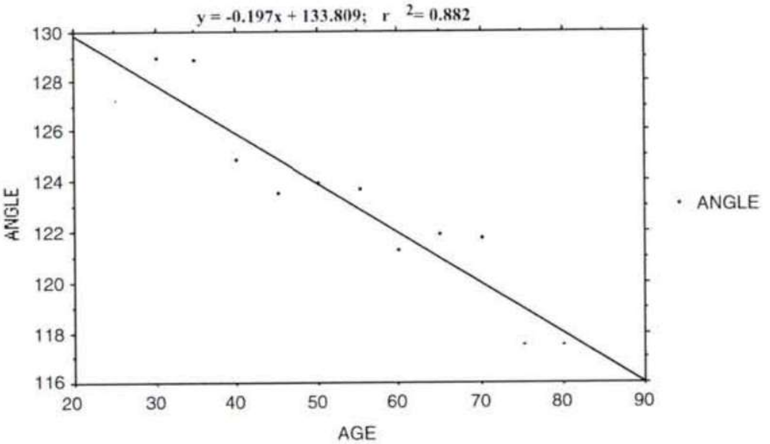

Fig. 2. Decrease in the mean value of the angle of LANDZERT with the age (regression curve) and the „stepwise" aspect of this decreasing phenomenon.

This study constitutes the first evidence of an age-related variation in the sphenoidal angle (main angle of cranial flexion) in adults. Some recent studies involving the use of magnetic resonance imaging indicated the age modification of the clivus bone marrow (OYAR et al., 1996), but did not take into account the sphenoidal angle. No evidence for a modification related to the sex, reported previously (CAMERON, 1927), was observed in our analysis. The mean value of the angle appeared to be statistically different as a function of the ethnicity: the Afroamerican sample presents a larger mean value.

Table 1. Means of the angles for the 4 successive stages of age.

	Number	Mean	ECART-type
Stage 1	82	128.45	8.61
Stage 2	118	124.08	9.20
Stage 3	62	121.51	8.43
Stage 4	32	117.03	11.66

However, the tendency is the same in the two samples ("black" and "white"), showing that the age is a major factor of the variation in the sphenoidal angle. The effect of the aging processes on the cranial base is characterized by an increase in the flexion of the base. The 5-year classification from 25 to 90 years revealed a "stepwise" decreasing phenomenon, with an r2 value of 0.882.

4 successive steps or stages can be discerned with this 5-year classification (Table 1):

- the first group is represented by people aged from 25 to 39 (stage 1), with a mean value of the angle of about 128°;

- the second group (stage 2) corresponds to the people aged from 40 to 59 years (sphenoidal angle mean value of about 124°);

- stage 3 is represented by individuals from 60 to 74 years old (about 121°);

- the people older than 75 years old (mean 116°) belong in the last category (stage 4).

The t-test confirms the validity of this classification, showing highly significant differences between the stages; for the intermediate categories (stages 2 and 3), the differences are only for a risk level of 0.1.

In fact, the ageing process of the flexion of the cranial base could evolve in adults in 3 major phases, correponding to 3 categories: young, middle-aged and old. When this classification is made, the differences are highly significant at a level of 0.05.

Conclusions

This new result is of interests from various aspects. From an anatomical point of view, it demonstrates the age-related variation in an anatomic structure which was hitherto considered to be stable in adults. From a paleontological point of view, it underlines the necessity of taking into account the intraspecific factor of variation in the phylogenetic recontruction, using the morphology of the cranial base. From an anthropologic and forensic points of view, it could constitute a new age indicator in adults. A more detailed analysis of this phenomenon and its causes will allow a clarification of its applications in the future.

References

AIELLO, L. and DEAN, C. (1990): An introduction to human evolutionary anatomy. - Academic Press, London.

ANTON, S. C. (1989): Intentional cranial vault deformation and induced changes of the cranial base and face. - Amer. J. Physical Anthropol. *79*, 253-267.

BJORK, A. (1955): Cranial base development. - Amer. J. Orthodontist *41*, 198-225.

BOLK, L. (1909): On the position and displacement of the foramen magnum in the Primates. - Verk. Akad. Wet. Amst. *12*, 362-377.

CAMERON, J. (1927): The main angle of cranial flexion (the nasion-pituitary-basion angle). - Amer. J. Physical Anthropol. *10*, 275-293.

LAITMAN, J. T., HEIMUBUCH, R. C. and CRELIN, E. S. (1978): Developmental change in a basicranial line and its relationships to the upper respiratory system in living primates. - Amer. J. Anatomy *152*, 467-483.

LEONETTI, G., SIGNOLI, M., HERSKOVITZ, I., LATIMER, B., TERVE, J. P., JELLEMA, L., CIANFARANI, F. and DUTOUR, O. (1997): Mise en évidence de l'effet du vieillissement sur l'angle sphénoidal du crâne humain. - Compte rendu de l'Académie des Sciences (submitted).

LIEBERMAN, PH. (1984): The biology and evolution of language. - Harward University Press, Cambridge (Mass).

MOSS, M. L. (1958): The pathogenesis of artificial cranial deformation. - Amer. J. Physical Anthropol. *16*, 269-285.

OLIVIER, G. (1960): Pratique anthropologique. - Vigot, Paris.

OLIVIER, G. (1965): Anatomie anthropologique. - Vigot, Paris.

OYAR, O., GOVSA, F., SENER, R. N. and KAYALIOGLU, G. (1996) - Assessment of normal clivus related to age with magnetic resonance imaging. - Surg. Radiol. Anat. *18*, 47-49.

ACTA BIOL. SZEGED. 42, pp. 251-257 (1997)

SOME ASPECTS OF THE REPRODUCTIVE BEHAVIOUR OF IMMIGRANT WOMEN IN SPAIN

M. D. MARRODÁN[1], C. PRADO[2], P. ACEVEDO[2], C. CUESTA[2], R. JUAN[2], E. PÉREZ DE LANDAZABAL[1] and A. SÁNCHEZ-ANDRÉS[3]

[1]*Sección de Antropología, Dpto. Biología Animal 1, Facultad de Ciencias. Biológicas, Universidad Complutense, 28040 Madrid, España;*

[2]*Sección de Antropología, Dpto. Biología, Facultad de Ciencias, Universidad Autónoma, 28049 Madrid, España;*

[3]*Departamento de Biología Animal, Facultad de Ciencias Biológicas, Universidad de Alcalá de Henares, Madrid, España.*

(Received: January 6, 1997)

Abstract

A diverse population of Third World and Eastern European immigrants now resides in Spain. Research was carried out to establish whether each of these migrant groups maintains its own reproductive patterns in the host country. This paper reports on five samples composed of 200 women originating from the Southern Cone, Central and South America, Africa, the Near East and Eastern Europe. Selected variables of the reproductive background were analysed: age at menarche, age at marriage, contraception, family size, child spacing, breast-feeding habits and post-partum amenorrhea.

Key words: reproductive behaviour, international migration, female bioanthropology, Spain.

Introduction

Women currently play a considerable role in international migrations, and female geographic mobility is no longer directly connected with family strategies (TAPINOS, 1990; CHAPMAN, 1991; BOIZMAN, 1993). It is becoming increasingly frequent for women to emigrate alone or with their children, without their husband (DAVID, 1990; MARRODAN et al., 1991; PEREDA and ACTIS, 1995; PIMENTEL, 1995).

The composition of the foreign population in Spain reveals an increasing proportion of women. In absolute numbers, we estimate that at the beginning of 1992 around 2000,000 women from the Third World and Eastern Europe were living in Spain. Two-thirds of these women are employed under legal, but unstable working conditions (MARRODAN and PRADO 1994). This situation creates new problems for the social services and the Spanish health authorities (Ministerio de Asuntos Sociales 1994). Plans have to be set in motion that are specifically aimed at the immigrant communities. However, for these plans to be effective, it is necessary to have a previous knowledge of the needs, the epidemiological characteristics and the cultural norms of each community. Previous studies in Spain have demonstrated that migration involves socio-economic groups differing in origin, religion and ethnic culture. (EMBAREK, 1994; GALLARDO, 1994; LOSADA, 1994; VARONA AND DAOLIO, 1994). The present work is focused on an investigation of whether reproductive traits likewise reflect the social features of female migration.

Through regional government financing (Autonomous Community of Madrid), our team is developing an investigation project on the bioanthropology of the immigrant women in Spain (PRADO et al., 1995). This paper presents preliminary results relating to some aspects of their reproductive pattern.

Subjects and methods

The sample comprises 200 adult women (married or single, but with a reproductive history) originating from the following regions:

a) Southern Cone (Argentina, Chile and Uruguay);
b) Central and South America (Peru, Colombia, Salvador, Cuba and the Dominican Republic);
c) Africa (Equatorial Guinea and Somalia);
d) the Near East (Iran and Iraq);
e) Eastern Europe (the previous Czechoslovakia, Hungary, Russia and Poland).

The woman studied were between 20 and 50 years old, with the following mean ages per group:
Africa: X = 32.50, SD = 3.30;
Central and South America: X = 34.90, SD = 4.76;
Southern Cone: X = 35.23, SD = 3.89;
the Near East: X = 35.04, SD = 4.76;
Eastern Europe: X = 35.40, SD = 5.25.

An interview was conducted with each individual. This provided retrospective information about reproductive traits, socio-economic characteristics and educational levels. The questionnaire summarized data about place and date of birth, numbers of brothers and sisters, birth rank, educational studies, employment before migration, date and circumstances of arrival in the host country, initial and subsequent working activities in Spain, etc. Questions relating to the standard of living and medical assistance were also included. The survey of the reproductive history extended to the age at menarche, the age at marriage, the type of union, the waiting time until the first birth, successive pregnancies with their outcomes, the sex of the children, the conditions of parturition, the duration of lactation, contraceptive practices and menstrual characteristics, the age at menopause and the incidence of menopausal syndromes. In this paper, we analyse in particular the following variables: the age at menarche, the age at marriage, the use of contraceptive methods, the family size, foetal losses, motherhood out of marriage, child spacing, breast-feeding habits and post-partum amenorrhea.

For the statistical processing, the BMDP (1987) programme was used. The multiple comparison of means was performed with the STUDENT-NEWMAN-KEULS test (SOKAL and ROHLF, 1981).

Results and discussion

The sample showed a wide range as concerns the professional and educational levels. A higher incidence of university studies was observed for women from East Europe (64.0%) and South America (43.6%), reflecting a highly qualified migration group whose target was not exclusively economic. Lower educational levels were found for African women, among whom 8.3% proved to be illiterate, and none of them in our sample had a university degree. In the same way, deficient schooling was observed among the Near East subsample, with 7.1% of illiterates. If we consider how these women were remunerated in their natives countries before moving to Spain, it is evident that a different social pressure was originally acting on them. In accordance with this situation, the African and Near East women in Spain are housewives or non-qualified workers, whereas those coming from Europe and America basically have an administrative status.

Table1. Reproductive traits in immigrants women residing in Spain.

	Southern cone		C. South America		Africa		Near east		Eastern Europe	
	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.
age at menarche (Years)	12.88	0.86	13.12	1.03	14.37	1.11	13.20	1.14	12.90	0.94
age at marriage (Years)	23.55	6.12	22.68	3.44	20.69	3.20	21.66	3.48	23.66	5.40
menarche-marriage period (Months)	10.65	3.99	9.44	3.35	6.62	5.50	8.38	4.88	10.61	2.71
marriage - 1st birth (Months)	13.60	8.08	17.28	9.21	28.44	6.94	22.20	9.45	16.85	9.59
1st - 2nd birth (Months)	30.78	10.44	31.04	9.00	29.90	8.48	29.39	14.24	27.53	13.80
2nd - 3rd birth (Months)	40.15	12.01	28.41	10.73	24.00	12.50	27.09	8.36	41.00	16.13
3rd - 4th birth (Months)	37.00	13.20	29.92	14.35	30.25	13.60	45.60	15.23	46.00	17.32
family size (Nº children)	1.25	1.03	2.62	1.45	2.85	0.68	2.81	0.53	1.58	0.42
breast-feeding duration (Months)	4.31	3.50	8.46	3.09	12.81	3.20	14.66	5.69	5.10	3.63
post-partum amenorrhea (Months)	3.04	3.68	7.82	6.80	10.44	3.15	9.38	4.95	4.37	2.80
single mothers (%)	12.50		7.500		6.00		0.00		13.00	
married women without children %)	19.62		13.00		6.00		0.00		15.00	
contraceptive users (%)	67.00		47.00		20.00		48.12		54.50	
foetal losses/woman (%)	0.20		0.28		0.07		0.23		0.55	

Table 1 lists results of the analysis events. The age at marriage seems to be conditioned more by sociocultural factors than by the biological fact that starts the reproductive period. Interestingly, the marital age displayed an inverse relation with the age at menarche. For instance, the women from the Southern Cone, who have the earliest menarche, marry the latest. On the other hand, the African women, who present the oldest menarcheal age, are the youngest in getting married. In fact, in the subsample from Africa, we found several cases of marriage before menarche.

If we consider the proportion of married women without children, we find differences among the five immigrant groups. 19.62% of the women from the Southern Cone do not have children, but there are no childless Muslim women from the Near East. Evidently, the proportion of married women without children emphasizes the distinct "reproductive mission" assigned socially to the women through marriage.

Maternity outside marriage is also an indicator of social permissivity among distinct cultural environments. We found the highest proportion of single mothers among the Eastern Europe (13%) and the Southern Cone (12.59%) groups. The percentage was lower among the women from Central and South America (7.5%), and we found no cases of single mothers originating from Iran or Iraq. On the other hand, 6% of the African women who had one or more children were single, though it should be noted that two-thirds of them married later. Unmarried mothers are not handicapped in any way in any of the societies. In fact, among Fang women from Guinea, for example, child-bearing is a guarantee of fertility, making it easier for a single mother to obtain a husband (SAINZ DE LA MAZA and GONZALEZ KIRCHNER, 1995).

The African immigrants have the largest families, with an average of 2.85 children per woman, followed by women from the Near East (2.81), Central and South America (2.62), Eastern European countries (1.58) and the Southern Cone (1.25). Two factors condition the family size: lactation and the use of contraceptive methods. In our survey, all of the African children, 99% of the children of the women from the Near East and 91% of the children of Central and South American women are breast-fed. The proportion of breast-feeding falls to 72% and 70% for the groups of mothers from Eastern Europe and the Southern Cone, respectively.

The duration of breast-feeding was longer than a year for the children of the Near East women (14.66 months) and the Africans (12.81 months). The Central and South American women breast-fed their children for an average of 8.46 months. The shortest breast-feeding periods were for the Eastern Europeans (5.17 months) and the Latin Americans from the Southern Cone (4.31 months). The period of post-partum amenorrhea exhibited identical tendencies. The duration of lactational infecundity was always less than the duration of breast-feeding. Surprisingly, amongst the women from the Near East amenorrhea (9.38 months) was on average 5 months shorter than the breast-feeding period (14.66 months). Nevertheless, it should not be forgotten that, although in general amenorrhea is prolonged when breast-feeding is practised, its duration depends on various factors, known and unknown: the morphophysiological and nutritional status of the woman at birth, the intensity of breast-feeding, etc. (HABITCH et al., 1985; LUNN, 1988; BERTRAND et al., 1990).

Those who use effective methods of contraception most frequently are the immigrants from the Southern Cone, with 67% of users, of whom 55% use oral contraceptives, 29% an I.U.D. and the remainder other methods, such as the diaphragm, condoms, etc. In contrast, only 20% of African women use contraceptives. They always use the pill, a habit they began in Spain.

In the African collective, the Near East and the Central and South American groups, all of the foetal losses were due to spontaneous miscarriages, whereas in the groups from the Southern Cone and Eastern Europe 25% and 58% of these losses were declared to be due to induced abortion. The highest abortion rate, for the European collective, can be considered to reflect a frequent "method" of contraception.

After marriage, the maximum waiting time before the first child was observed for the African women (28.44 months) and those from the Near East (22.20 months). Both groups married at the youngest age and had the shortest interval between menarche and marriage. This relatively long waiting period is possibly due to physiological conditions rather than a voluntary desire not to conceive. However, the shorter protogenesic interval (from marriage to first birth) was observed among the women from the Southern Cone, who marry later. It can be deduced from this that a marriage takes place if the couple immediately plan to start a family.

The child spacing displays a tendency to a rhythmic reproduction (with regular genesic gaps) among the African women, those from the Near East and the Central and South Americans. In the Eastern Europeans and the natives of the Southern Cone, the option appears to be a shortening of the effective reproductive period, with intervals of longer duration between successive births.

Table 2. Multiple comparison of reproductive variables among immigrant groups. (STUDENT-NEWMAN-KEULS test)

Mean of: Age at marriage (years)	Eastern Europe	Southern Cone	C.South America	Near East	Africa
	23.66	23.55	22.68	21.66	20.69
	N.S. (Eastern Europe – C.South America)		X	N.S. (Near East – Africa)	
Mean of: Menarche-marriage period (months)	Southern Cone	Eastern Europe	C.South America	Near East	Africa
	10.65	10.61	9.54	8.38	6.62
	N. S. (Southern Cone – Eastern Europe)	X	X (C.South America – Africa)		
Mean of: Marriage-1st birth (months)	Africa	Near East	C.South America	Eastern Europe	Southern Cone
	28.44	22.2	17.28	16.85	13.60
	N. S. (Africa – Near East)	X	N. S. (C.South America – Southern Cone)		
Family size (child number on average)	Africa	Near East	C.South America	Eastern Europe	Southern Cone
	2.85	2.81	2.62	1.58	1.25
	N.S. (Africa – C.South America)		X	N. S. (Eastern Europe – Southern Cone)	
Breast-feeding (months)	Near East	Africa	C.South America	Eastern Europe	Southern Cone
	14.66	12.81	8.46	*5.10*	4.31
	N.S. (Near East – Africa)	X	X	N.S. (Eastern Europe – Southern Cone)	

N.S.: not significant differences; *X*: significant differences between clusters

The test of STUDENT-NEWMAN-KEULS for selected variables of reproductive background revealed significant differences among the five immigrant collectives (Table 2). These indicate two reproductive models. One is for the Eastern Europeans and the natives of the Southern Cone: a marital age above 23 years, a menarche - marriage period longer than 10 years, a short protogenesic interval, small families of less than 2 children and breast-feeding of less than 6 months on average. The second model is that of the Central and South Americans, the women from the Near East and the Africans. It is characterized by marriage before 22 years of age, a menarche - marriage period of less than 9.5 years, a relatively long marriage - first birth interval, a family size of more than 2 children and a breast-feeding period of more than 1 year.

Conclusions

The immigrant females in Spain exhibit reproductive behaviour reflecting the social development and cultural traditions of the geographic areas of origin. After moving, some changes occur: the discovery of new methods of contraception, a reduction of breast-feeding by women at work, etc. The phenomenon of culturization, which may be drastic in some cases, can eventually alter the balance of the reproductive pattern of each population in certain respects. This should be taken into consideration at the time of planning social action aimed at demographic control and health protection of immigrant groups in the host country.

Acknowledgements

This research was supported by the finance of the Ministerio de Educación y Ciencia (D.G.I.C.Y.T) Project no. PB92-0136. The authors also wishes to thank Dr. Jesús Alcaráz Esteban and Centro de Salud para Inmigrantes del Exmo. Ayuntamiento de Majadahonda.

References

BERTRAND, J. T., CHIRHAMOLEKWA, C., DJUNGHU, B., CHIBALONZA, K. and MAHAMA, K. (1990): Post-partum events and fertility control in Kinshasa. - J. Biosoc. Sci. *22*, 197-211.

BMDP (1987): Biomedical Data Programm. - Los Angeles Statistical Software. Inc., Los Angeles, California.

BOLZMAN, C. (1993): La place des femmes dans une émigration politique. L'exemple de l'exil chilien vers la Suisse. In: Vers un allieurs prometteur. L'émigration, une résponse universelle à une situation de crise? - Cahiers de l'IUED. Paris, Geneve, 184-198 pp.

CHAPMAN, J. (1991): Factors in Nineteenth Century Swiss Emigration to the United States. Table Ronde sur La Place des Femmes dans l'émigration. Colloque Pluridisciplinaire: L'émigration, une résponse universelle à une situation de crise?. - Laboratoire de Démographie Economique et Social de L'Université de Geneve.

DAVID, I. (1990): Situación de las mujeres iberoamericanas en Espaha. In: Fundación CIPIE y Departamento de Sociologia de la Universidad Autónoma de Barcelona (ed.): Las mujeres en América Latina, una aproximación necesana, 57-65 pp.

EMBAREK, M. (1994): Mujeres emigrantes marroquíes en Madrid, historias de vida. In: LEZCANO, M. (ed.): El desafío de la migración en la España actua: una perspectiva europea. - Ed. UNED, Madrid.

GALLARDO, G. (1994): Buscando la vida: dominicanas en el servicio doméstico. - Ed. IEPALA, Madrid.

HABITCH, J., DAVANZO, J., BOTZ, W. P. and MEYERS, L. (1985): The contraceptive role of breast-feeding. - Population Studies *39*, 213-232.

LOSADA, T. (1994): Socialización de los inmigrantes marroquíes. - Documentación Social *97*, 235-242.

LUNN, P. G. (1988): Malnutrition and fertility. In: DIGGONS, POTTS and TEPER (eds): Natural human fertility. Social and biological consequences. - The Eugenic Society.

MARRODÁN, M. D., DAVID, I., SANCHO, C., SANTAMARTA, C. and RELANO, A. (1991): Mujeres del Tercer Mundo en España. Modelo migratorio y caracterización sociodemográfica. - Ed. CIPIE, Madrid.

MARRODÁN, M. D. and PRADO, C. (1994): Las Migraciones: su repercusión en la sociedad y en ta Biologia de las Poblaciones Humanas. - Ediciones Universidad Autónoma de Madrid, Madrid.

Ministerio de Asuntos Sociales (1994): Informe sobre el foro familia y migraciones. - Madrid.

PEREDA, C. and ACTIS, W. (1995): Recent migration dynamics in Spain. Their effects on social integration/exclusion processes. I International Meeting on Immigration Health and Social Policies. - Centre for Mexican American Studies of University of Texas at Atlanta, Escuela de Salud Pública de Granada y Universidad Euroárabe, Granada.

PIMENTEL, A. (1995): Notas sobre la IV Conferencia Mundial de la Mujer. - Ed. Fundación Promoción Social de la Cultura, Madrid.

PRADO, C., MARTINEZ, R., PÉREZ DE LANDAZABAL, E., MARRODÁN, M. D., SÁNCHEZ-ANDRÉS, A. and NIELSEN, A. H. (1995): La mujer inmigrante en España. In: BOTELLA, M., DU SOUICH, P.H., JIMENEZ, S. and RUIZ, L. (eds): Nuevas perspectivas en Antropologia Biológica. - Diputación Provincial de Granada, 783-789 pp.

SAINZ DE LA MAZA, M. and GONZALEZ-KIRCHNER, J. P. (1995): Epidemiología y salud reproductiva de la población Fang de Guinea Ecuatorial. - Ed. CEIBA, Madrid.

SOKAL, R. R. and ROHLF F. J. (1981): Biometría. Principios y métodos estadísticos en la investigación bio lógica. - Ed. H. Blume, Madrid.

TAPINOS, G. P. (1990): Immigration féminine et statut des femmes étrangères en France. - Ed. Institut National d'Etudes Démographiques, Paris.

VARONA, M. and DAOLIO, N. (1994): Immigración en España: femenino y plural. - Federación de Mujeres Progresistas, Dirección General de Migraciones.

ACTA BIOL. SZEGED. 42, pp. 259-264 (1997)

BODY COMPOSITION AND PEAK EXERCISE HAEMATOLOGY IN ADULT MALES

J. MÉSZÁROS, J. MOHÁCSI, M. PETREKANITS, A. FARKAS and R. FRENKL

Department of Health Sciences and Sports Medicine, Hungarian University of Physical Education H-1123 Budapest, Alkotás u. 44., Hungary

(Received: November 10, 1996)

Abstract

The relative plasma volume decrease has mostly been studied in exercises of long duration and without respect to habitual physical activity. Anthropometric characteristics and peak-exercise plasma volume decrease were compared in adult male non-athletic subjects (n = 20), PE students (n = 25) and League I soccer players (n = 25). Height, body mass, CONRAD (1963) indices, muscle and fat mass were compared. The all-out exercise was performed on the treadmill. Haematology was studied by the QBC AUTOREADER technique at rest and immediately after exercise in 30 µl arterialized blood samples. The relative plasma volume decrease was estimated by the method of GREENLEAF and HINGHOFER-SZALKAY (1985) With the exception of the mononuclear percentage, the initial haematology was similar in all groups. The peak-exercise plasma volume decrease was significantly smaller and the mononuclear percentage was significantly larger in the physically active groups. The greater mononuclear percentage is likely to be one of the indicators of those regulatory processes that play an important part in the appearance of the smaller peak-exercise plasma volume decrease in the physically active groups.

Key words: plasma volume decrease, physical activity, body composition, all-out exercise

Introduction

Increased resting blood and/or plasma volumes induced by regular physical training have been reported by several authors in the past two decades (CONVERTINO et al., 1980; COLLINS et al., 1986; SCHMIDT et al., 1988). Since this increase in blood/plasma volume can develop even after only some weeks of regular endurance training, it may be considered an early sign of cardiorespiratory and metabolic adaptation to exercise. An experimentally increased resting plasma/blood volume (within the range 400-700 ml) has been found to be favourable by allowing a larger stroke volume and cardiac output (HOPPER et al. 1988).

FORTNEY et al. (1983) made the exercise-physiologically intriguing statement that the exercise decrease of the blood or plasma volume was directly proportional to the stroke volume, and in this way to the cardiac output measured during submaximum exercise. Thus, cardially very fit athletes having an exceptionally high aerobic power, i.e. maximum stroke volume and cardiac output, would be in a less advantageous position than non-athletes, since in this way the haemoconcentration would be more marked in them and therefore impair their physiological performance.

The purpose of the present study was to compare the peak-exercise plasma volume decreases in young adult males of different habitual physical activity.

Our research hypothesis was as follows. Cardially well-trained athletes have a larger stroke volume and cardiac output during exercise (BLOMQVIST and SALTIN, 1983). If the plasma volume decrease were directly related to the cardiac output or stroke volume, the plasma volume decrease during exercise should be smaller in non-athletic subjects.

Subjects and methods

The investigated subjects were volunteers:

1. Adult male League I soccer players (n = 25) participating in 11 intense training sessions and at least one competition per week.

2. Students at the Hungarian University of Physical Education (n = 25) taking part in 5 practical sessions (of 90 min. each) and 3-5 event training sessions of high intensity per week.

3. Non-athletes (n = 20) performing a maximum of 2 hours a week of non-regular fitness activity.

The members of Groups 1 and 2 held sport medical licences for competitions; the non-athletic subjects underwent detailed internal medical and cardiorespiratory screening before the data collection.

For the sake of comparability, the subjects' relative body linearity and skeleto-muscular robustness were described by CONRAD's (1963) metric and plastic indices. The metric index is the ratio of chest breadth to chest depth, corrected for height. The plastic index is the sum of shoulder width, lower arm girth and hand circumference.

Body mass-related muscle and fat masses were estimated by the DRINKWATER and ROSS (1980) body mass fractionation technique and expressed as percentages. In the measurement of the necessary body dimensions, the IBP suggestions (WEINER and LOURIE, 1969) were observed.

The all-out laboratory exercise was performed on the treadmill. The test exercise began at a 12 km/h belt speed and zero level of inclination after individual warming-up. (The soccer players and university students warmed up independently; for the non-athletes, the warming-up was directed by a PE teacher and consisted of callisthenics, skipping, jogging and stretching exercises). The belt inclination was increased by 3% every second minute until exhaustion. The belt was stopped by the subjects.

Peak exercise serum lactate levels were measured with an LP-20 miniphotometer (Dr. LANGE, Germany) in 10 µl capillary blood samples. Haematology (haematocrit, haemoglobin level, white blood cell count, granulocyte and lymphocyte + monocyte percentage) was determined by the QBC AUTOREADER (USA) technique, using 30 µl arterialized blood samples. Blood was sampled at rest (before the anthropometric data collection) and immediately after stopping the exercise, from the fingertip in the sitting position.

The post-exercise relative plasma volume was calculated by the equation of GREENLEAF and HINGHOFER -SZALKAY (1985):

$$PV\% = 100 \times [HGB_b \times HGB_a^{-1} \times (1\text{-}HCT_a) \times (1\text{-}HCT_b^{-1})]$$

where PV% = relative plasma volume as a percentage of the initial volume, HGB = haemoglobin concentration ($g \times 100\ ml^{-1}$), HCT = haematocrit (%), b = before exercise, a = after exercise.

Means and standard deviations of the anthropometric and haematological parameters were tested by F-test at the 5% level of random error after one-way ANOVA. Differences between the resting and post-exercise variable means were analyzed by t-tests for dependent samples.

Results and discussion

The first part of this section contains the results of the studied anthropometric variables, while in the second part the haematological and plasma volume changes are reported.

Statistical means and standard deviations of the anthropometric variables are listed in Table 1. The mean calendar age of the non-athletes was significantly greater than that of the university students and soccer players, but in this young adult age range no particular importance was attributed to a difference of 2-4 years.

Table 1. Basic statistics of the compared anthropometric variables.

	Non-athletes		University students		Soccer players		
Variable	Mean	SD	Mean	SD	Mean	SD	P
DA(yr.)	27.20	2.53	23.14	2.27	25.47	3.50	< 5%
BH (cm)	175.89	6.23	180.84	6.09	181.73	4.84	< 5%
BM (kg)	77.43	6.46	74.21	5.95	73.04	4.87	< 5%
M(%)	45.01	1.11	48.79	1.06	49.25	1.14	< 5%
F(%)	15.55	2.83	9.23	1.58	9.03	1.20	< 5%
MIX (cm)	–0.85	0.29	–1.14	0.28	–1.27	0.24	< 5%
PLX (cm)	86.08	3.12	88.96	3.26	91.41	2.25	< 5%

Abbreviations: DA = chronological age expressed in decimal years, BH = height, BM = body mass, M = body mass-related muscle mass, F = body mass-related fat mass, MIX = metric index, PLX = plastic index, < 5% = the difference between the compared means is statistically significant.

The non-athletes were significantly shorter and heavier than the university students and soccer players (termed active groups hereafter). Both active groups had significantly greater muscle and markedly lower fat percentage means. The growth type of the non-athletes was metromorphic and normoplastic according to the CONRAD (1963) categories. The active groups could be qualified as hyperplastic and slightly leptomorphic. The leptomorphy was rather "athletic" and not extremely linear, as one of the consequences of sports selection effects (MÉSZÁROS and MOHÁCSI, 1982a; 1982b; MOHÁCSI and MÉSZÁROS, 1982). The well-developed bone-muscle system was attributed to their regular physical activity. All the studied anthropometric characteristics of the PE students and soccer players were statistically the same.

The basic statistics of the physiological variables are summarized in Table 2. An evaluation of the statistically different running distances (all three means were different from each other) and the really high associated blood lactates (no essential differences were found between the means) clearly revealed that the investigated subjects performed at (or very near to) their momentary maximum. In absolute terms, the physical performances of groups were naturally different, but all three groups worked at their physiological maximum, so this is the basis of the present comparison.

No significant differences were found in the resting haematological group means. (The observed means were very near to the centre of the physiological ranges.) The only exception among the studied haematological parameters was the lower resting mononuclear percentage of the non-athletes. In other words, the two active groups had greater resting lymphocyte and monocyte counts at rest. This finding agrees with the observations of KEAST et al. (1988) and MACKINNON (1989): Regular physical activity has positive effects on the immune functions, represented by an increased lymphocyte count and also an increased activity of lymphocytes and other parts of the lymphatic immune system.

The initial haemoglobin and haematocrit levels and total white blood cell count increased significantly in all groups during the applied all-out exercise, a well-known consequence of long- or short-term (but intense) physical exercise (see SENAY and PIVARNIK, 1985; SCHMIDT et al.,1989; NG et al.,1996). Although there were no statistical differences between the exercise-induced haemoglobin and haematocrit increases, the differences between the calculated mean plasma volume decreases were significant. In the two active groups, the relative plasma volume decrease was of a similar extent and significantly smaller than in the non-athletes.

Table 2. Means and standard deviations of the physiological parameters

Variable	Non-athletes		University students		Soccer players		P_F
	Mean	SD	Mean	SD	Mean	SD	
HCTb	46.00	0.89	46.16	1.00	46.24	0.81	NS
HCTa	49.68	1.58	48.79	1.79	49.01	1.52	NS
P_t	< 5%		< 5%		< 5%		
HGBb	15.05	0.59	15.21	0.61	15.11	0.52	NS
HGBa	16.68	0.61	16.38	0.76	16.15	078	NS
P_t	< 5%		< 5%		< 5%		
WBCb	5.10	0.58	5.39	0.60	5.05	0.45	NS
WBCa	8.58	1.39	8.85	1.35	9.21	1.19	NS
P_t	< 5%		< 5%		< 5%		
L+M%b	41.30	5.35	39.16	5.07	35.71	4.97	< 5%
L+M%a	45.30	6.60	53.40	6.39	54.45	6.31	< 5%
P_t	< 5%		< 5%		< 5%		
LA	15.06	2.94	15.60	2.86	14.82	2.17	NS
RD	1665.55	328.99	2362.76	281.55	2881.12	214.23	< 5%
PV%a	84.08	2.55	88.32	2.19	88.57	2.03	< 5%

Abbreviations: HCT = haematocrit (%), HGB = haemoglobin (g × 100 ml^{-1}), WBC = white blood cell count (1000 × μL), L+M% = ratio of lymphocytes + monocytes in the measured WBC (%), LA = blood lactate concentration (mmol × L^{-1}), RD = running distance (m), PV% = peak exercise plasma volume as a percentage of the initial value, P_F < 5% = the difference between the group means is significant at the 5% level of random error, P_t < 5% = significant difference before and after the exercise, NS = non-significant.

The post-exercise mononuclear percentages in the increased white blood cell count were also different between the active and non-active groups. This exercise-induced response was significantly greater in the university students and soccer players.

The international literature and the present results indicate that the plasma volume decrease during any physical activity is one of the consequences of exercise itself. The mechanisms of the decrease have not yet been clarified in detail.

SENAY and PIVARNIK (1985), and NIEMAN (1995) have described that, during graded exercise, 10 to 20% of the plasma volume leaves the blood and enters the active muscle tissue. This plasma volume shift, combined with the fluid loss from sweating, would lead to an increase in the thickness of the blood, called haemoconcentration.

WILMORE and COSTILL (1994) explained the plasma volume decrease as arising from an increased blood pressure and the changed metabolism of the working muscle. In contrast, NG et al., (1996) and MÉSZÁROS et al., (1996) found that, under laboratory conditions, the peak-exercise plasma volume decrease failed to correlate with the extent of fluid loss (either during exercise or sitting in a sauna), with the increased systolic blood pressure or with the increase in running distance. Instead, they reported a slight but significant relationship between the peak-exercise plasma volume decrease and the anthropometrically estimated muscle mass expressed as a percentage.

In the interpretation of WILMORE and COSTILL (1994), the fluid shift from the circulation to the working muscle is favourable in respect of its metabolism. However, the plasma volume decrease is unfavourable for the cardiac functions during high-intensity exercise (HOPPER et al., 1988).

Theoretically, the circulating plasma volume at or around peak-intensity exercise is the joint effect of the circulatory redistribution (BLOMQVIST and SALTIN, 1983; GISOLFI, 1983), the fluid shift towards the working muscle (STEPHENSON and KOLKA, 1988; SCHMIDT et al., 1989; NG et al., 1996) and the resting blood/plasma volume, which is increased in well-trained subjects (CONVERTINO et al., 1980; COLLINS et al., 1986; SCHMIDT et al., 1988).

Though the effects of the intracirculatory redistribution are measurable and cannot be neglected, they seem to be less important in respect of this specific kind of plasma volume decrease. Redistribution *per se* cannot completely compensate for the fluid loss, because some exercise-induced plasma volume decrease occurs consistently in everybody. In respect of the mentioned cardiac functions (stroke volume and cardiac output) and blood viscosity, within the physiological range a larger initial blood or plasma volume and a smaller plasma volume decrease would be favourable for any physical effort.

The present results have shown that the plasma volume decrease is significantly smaller in physically active students and endurance-trained soccer players. Taking all the studied effects in combination, it is the healthy but untrained organism that appears in a worse condition, because its initial blood volume is smaller and its plasma volume decrease during exercise is greater than in physically more active subjects.

The greater mononuclear percentage is likely to be one of the indicators of those regulatory processes that play an important part in the appearance of a smaller peak-exercise plasma volume decrease in physically active groups.

In conclusion, our working hypothesis had to be discarded, because the relative plasma volume decrease was significantly greater in non-athletic subjects than in the two investigated active groups. In respect of physical performance, the latter represent the more preferable state.

References

BLOMQVIST, C. G. and SALTIN, B. (1983): Cardiovascular adaptations to physical training. - Annual Rev. Physiology *45*, 169-189.

COLLINS, M. A., HILL, D. W., CURETON, K. J. and DEMELLO, J. J. (1986): Plasma volume change during heavy-resistance weight lifting. - European J. Appl. Physiology *55*, 44-48.

CONRAD, K. (1963): Der Konstitutionstypus. - Berlin, Springer Verlag.

CONVERTINO, V. A., BROCK, P. J., KEIL, L. F., BERNAUER, E. M. and GREENLEAF, J. E. (1980): Exercise training induced hypervolemia: role of plasma albumin, renin, and vasopressin. - J. Appl. Physiology *48*, 665-669.

DRINKWATER, D. T. and ROSS, W. D. (1980). Anthropometric fractionation of body mass. In: OSTYN, M., BEUNEN, G. and SIMONS, J. (eds): Kinanthropometry II. - Baltimore: University Park Press, 178-189.

FORTNEY, S. M., WENGER, C. B., BOVE, J. R. and NADEL, E. R. (1983): Effect of blood volume on forearm venous and cardiac stroke volumes during exercise. - J. Appl. Physiology *55*, 844-890.

GISOLFI, C. V. (1983): Temperature regulation during exercise: Directions - 1983. - Med. Sci. Sports Exerc. *15*, 15-20.

GREENLEAF, J. E. and HINGHOFER-SZALKAY, H. (1985): Plasma volume methodology: Evans blue, hemoglobin-haematocrit, and mass density transformations. - NASA Technical Memorandum 86834, Moffet Field, CA.

HOPPER, M. K., COGGAN, A. R. and COYLE, E. F. (1988): Exercise stroke volume relative to plasma-volume expansion. - J. Appl. Physiology *64(1)*, 404-408.

KEAST, D., CAMERON, K. and MORTON, A. R. (1988): Exercise and immune response. - Sports Medicine 5, 248-267.

MACKINNON, L. T. (1989): Exercise and natural killer cells. What is the relationship? - Sports Medicine *7*, 141-149.

MÉSZÁROS, J. and MOHÁCSI, J. (1982a): The somatotype of Hungarian male and female class I paddlers and rowers. - Anthropológiai Közlemények *26*, 175-179.

MÉSZÁROS, J. and MOHÁCSI, J. (1982b): An anthropometric study of top-level athletes in view of the changes that took place in the style of some ball games. - Humanbiologia Budapestinensis *13*, 15-20.

MÉSZÁROS, J., MOHÁCSI, J., FRENKL, R., FARKAS, A. and PETREKANITS, M. (1996): Age dependence of plasma volume decrease during all-out exercise in athletic boys. - Fiziologia-Physiology, Official Journal of the Romanian Society of Physiological Sciences *(2)10*, RE12.

MOHÁCSI, J. and MéSzáros, J. (1982): Serdülőkorú úszók testalkati és fiziológiai vizsgálata. - Humanbiologia Budapestinensis *13*, 21-25.

NIEMAN, C. D. (1995): Fitness and sports medicine. A health-related approach. - Palo Alto, CA: Bull Publishing Company, 189.

NG, K. N., MÉSZÁROS, J. and FARKAS, A. (1996): The relationship between relative blood plasma change and anthropometric and physiological variables during exercise. - Fiziologia-Physiology, Official Journal of the Romanian Society of Physiological Sciences *(2)10*, RE14.

SCHMIDT, W., MAASSEN, N., TROST, F. and BÖNING, D. (1988): Training induced effects on blood volume, erythrocyte turnover and haemoglobin oxygen binding properties. - European J. Appl. Physiol. 57, 490-498.

SCHMIDT, W., MAASSEN, N., TEGTBUR, U. and BRAUMANN, K. M. (1989): Changes in plasma volume and red cell formation after a marathon competition. - European J. Appl. Physiology *58*, 453-458.

SENAY, L. C. and PIVARNIK, J. M. (1985): Fluid shift during exercise. - Exerc. Sport Sci. Rev. *13*, 335-387.

STEPHENSON, L. A. and KOLKA, M. A. (1988): Plasma volume during heat stress and exercise in women. - European J. Appl. Physiology 57, 373-381.

WEINER, J. E. S. and LOURIE, J. A. (eds) (1969): Human Biology. A Guide to Field Methods. - IBP Handbook, No. *9*., Oxford, Blackwell.

WILMORE, J. H. and COSTILL, D. L. (1994): Physiology of sport and exercise. Champaign, IL: - Human Kinetics 184-185.

ACTA BIOL. SZEGED. 42, pp. 265-269 (1997)

DATA ON THE HEAD SIZES OF YOUNG PEOPLE IN NÓGRÁD COUNTY (HUNGARY)

K. NYILAS and T. G. SZABÓ

Bessenyei György Teacher's Training College, H-4401 Nyíregyháza, Sóstói ut 31/B, Hungary

(Received: December 10, 1996)

Abstract

The most important data on the head and face sizes of 834 boys and 1086 girls between the ages of 11 and 18 years were collected by researchers in Nógrád County as part of wider-ranging research. Since there are only a few publications in Hungary on this field, and on Nógrád there are no data at all, parameters and indices calculated from parameters of head length, head breadth, bizygomatic breadth, face height, head height and head circumference are published in this article. A comparison is made with growth standards calculated for Hungarian children.

Key words: head and face measurements, 11-18 -year age group, growth standard

Introduction

The sample reported on in this article relates to anthropological data collected between 1981 and 1984. We were focusing on the theme of "adolescence and the environment" (FARKAS, 1990), but at the same time the anthropological programme included the most important head measurements on children in Nógrád County.

834 boys and 1086 girls fell into the age category 11-18 years. The ages of the students were categorized according to the decimal table (FARKAS, 1973). The basic statistical parameters were calculated by PÉTER HUNYA and ISTVÁN HERENDI on a R-40 computer in the KALMÁR LÁSZLÓ Cybernetic Laboratory at JATE, Szeged and we would like to express our thanks to them here for their work.

In the anthropometric work, the techniques of MARTIN and SALLER (1956) were applied, and guidelines of the International Biological Programme (TANNER et al., 1969) and FARKAS (1996) were also considered.

It should be emphasized that the Nógrád sample is part of the sample used for the calculation of the national growth standards (FARKAS and NYILAS, 1988; FARKAS and NYILAS, 1996). The sample is too small to reflect the whole of the young population of Nógrád, but it is an essential part of the national growth standards.

Results and discussion

Data on head sizes are rarely found Hungarian or foreign publications. It is of importance, however, in examinations of growth in young people, because head growth is very intense in childhood, but particularly so at the peak height velocity in adolescence.

In our sample, the steadily increasing tendency of the averages counted for one-year age groups (Tables 1-6) was only interrupted in a few cases by decreasing values (for girls this was more frequent than for boys). These decreases were in almost all cases insignificant, around 1 mm.

The boys' averages were always higher as regards maximal head length (g-op) (Table 1). According to the LEBZELTER and SALLER scale, the 11-year-old boys belong in the short, the 12-15-year-old boys and the 11-13-year-old the medium-long, and the 16-18-year-old boys and the 14-18-year-old girls in the long category. The averages for both sexes fall in the 50% zone of the national growth standard.

Table 1. Parameters of maximum head length (g-op).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	177.47	7.01	162-195	11	95	173.45	6.71	152-192
161	178.66	6.56	164-197	12	144	174.60	6.87	157-195
149	178.37	6.31	162-196	13	152	176.57	5.71	163-192
164	181.88	6.39	164-195	14	139	178.37	6.18	164-193
100	183.96	6.90	171-200	15	156	179.63	6.42	162-196
58	188.48	7.38	172-205	16	147	180.80	6.54	163-197
59	189.75	5.63	171-201	17	139	180.88	7.01	164-204
47	189.89	7.88	176-210	18	114	180.20	7.13	162-198
831					1528			

As concerns the maximal head breadth (eu-eu), the boys' averages are higher in every age group than the girls' (Table 2). Applying the Saller categorization, the boys at the age of 17, and the girls at the age of 14 step over from the medium-wide group to the wide group. The data on both boys and girls vary around the 50th percentile.

Table 2. Parameters of greatest head breadth (eu-eu).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	151.62	5.34	138-165	11	95	147.77	5.53	132-161
162	151.72	5.84	136-167	12	142	147.03	5.46	134-163
149	153.81	5.49	140-168	13	151	149.00	5.56	133-162
165	154.60	6.09	139-169	14	139	151.06	5.39	134-164
99	155.92	6.37	139-173	15	156	150.71	5.91	135-167
57	155.86	6.03	143-170	16	147	151.81	5.22	140-165
58	158.09	6.00	146-170	17	139	152.50	5.75	139-169
47	157.02	5.61	141-170	18	114	151.52	6.01	140-167
830					1083			

The average bizygomatic breadth (zy-zy) for the boys increases more steadily than for the girls, and were always larger than those of the girls. Using the Lebzelter and

Saller categorization, every age group for the girls and the 11-14-year-old boys belong in the narrow category, while the 15-18-year-old boys belong in the medium-wide category. The averages fit well to the 50% graph.

Table 3. Parameters of bizygomatic breadth (zy-zy).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	128.56	5.62	116-148	11	95	126.52	4.77	115-137
162	129.50	5.26	118-144	12	144	127.92	5.46	117-145
150	131.47	5.01	118-145	13	152	130.88	5.03	119-143
165	134.75	5.78	121-151	14	139	133.55	4.80	123-151
100	136.99	5.54	118-150	15	156	133.38	4.68	122-150
58	137.47	6.25	116-153	16	147	134.33	4.47	124-148
59	140.41	4.63	132-154	17	139	135.42	4.52	126-145
47	140.21	5.44	127-155	18	114	134.21	4.35	124-143
834					1086			

The face height (morphological) (n-gn) shows an increasing tendency (except for the 18-year-old girls). The average for 13-year-old girls is 0.02 mm higher that for the boys of the same age. The increase is steadier for the girls (Table 4). The averages correspond to the 50% development level.

Table 4. Parameters of total face height (n-gn).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	100.17	5.02	86-112	11	95	98.66	4.56	86-110
162	101.96	5.66	87-116	12	144	100.85	5.42	87-114
150	103.49	5.77	85-117	13	152	103.51	5.19	90-119
165	108.26	6.01	93-123	14	139	104.93	5.64	88-122
100	111.01	6.50	92-125	15	156	106.48	5.09	96-121
58	112.52	7.22	99-134	16	147	106.80	5.32	93-123
58	114.22	6.80	102-132	17	139	106.80	6.48	75-119
47	116.30	7.76	101-135	18	114	106.19	5.68	90-119
833					1086			

The head height (gn-v) grows continuously until the age of 18 for boys, while it ends at the age of 14 for girls. This fact makes the difference between the sexes more implicit (Table 5). This does not show up from the comparison with the standard.

Table 5. Parameters of total height (gn-v).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	198.19	9.57	174-227	11	95	190.51	8.95	167-212
162	199.86	9.79	169-225	12	144	194.57	8.86	163-213
149	202.20	9.97	181-231	13	151	198.41	10.12	153-219
165	209.38	10.58	185-239	14	139	201.96	9.30	176-223
99	209.56	10.16	188-237	15	156	200.65	9.35	179-227
57	212.91	8.88	186-232	16	147	201.51	9.30	174-225
58	213.55	8.61	195-231	17	139	200.32	8.65	179-220
47	217.68	10.35	201-239	18	112	197.90	9.37	174-219
830					1083			

The average maximum head circumference is obviously larger for boys in all age groups (Table 6). The arithmetic averages of the age groups fall into the 50-75% zone of the percentile graphs.

Table 6. Parameters of head circumference.

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	530.06	14.29	493-576	11	95	519.94	14.31	471-552
162	533.23	13.72	501-575	12	144	523.74	14.23	483-566
150	536.61	15.19	488-573	13	152	531.43	15.09	499-566
165	547.36	16.12	497-598	14	137	537.58	12.89	508-573
99	552.27	15.50	520-584	15	155	539.74	13.54	500-574
58	559.48	17.63	528-594	16	147	543.07	14.09	502-589
59	566.49	11.54	542-596	17	139	544.76	14.99	515-588
47	567.36	17.88	530-608	18	114	542.10	14.08	492-578
833					1083			

The value of the cephalic index (3:1) fluctuates somewhat with age (Table 7). With the exception of 5-year-old boys who are in the hyperbrachycephalic region, the young population of Nógrád are brachycephalic. The averages vary around the 50th percentile.

Table 7. Parameters of cephalic index (3:1).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	85.17	4.75	74-69	11	95	84.78	4.17	72-95
161	84.54	4.54	75-97	12	142	83.73	3.91	74-94
148	85.82	3.81	75-97	13	151	83.94	3.65	74-93
164	84.63	4.30	74-95	14	139	84.27	3.89	75-96
99	84.40	4.56	74-94	15	156	83.50	4.23	72-94
57	82.19	3.84	74-93	16	147	83.61	4.15	74-94
58	82.94	3.96	76-93	17	139	83.95	4.36	72-94
47	82.34	4.31	71-91	18	114	83.71	4.58	72-97
827					1083			

The average morphological facial index (18:6) in both sexes shows an increasing tendency (Table 8). The 11-13-year-old boys fall into the hypereuryprosopic category, and the other age groups in both sexes into the euryprosopic category. The averages lie around the 50th percentile here too.

Table 8. Parameters of facial index (18:6).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	77.51	4.02	68-88	11	95	77.61	4.17	69-87
162	78.28	4.31	66-90	12	144	78.43	4.16	69-89
150	78.26	4.21	65-92	13	152	78.67	4.12	68-92
165	79.90	4.18	66-90	14	139	78.16	4.30	66-88
100	80.59	3.99	71.92	15	156	79.36	4.23	71-92
58	81.43	4.97	70-97	16	147	79.08	4.29	68-91
58	80.87	4.76	71-91	17	139	78.43	4.43	57-88
47	82.57	5.85	69-94	18	114	78.69	4.15	67-90
833					1086			

The transverse cephalofacial index (6:3), similar to the morphological facial index, displays a rising tendency (Table 9).

The averages indicate micropsidic zygoma in all age groups in both sexes, appearing around the 50% zone.

Table 9. Parameters of transversal cephalo-facial index (6:3).

Boys				Age (year)	Girls			
n	$\bar{x}$	s	w		n	$\bar{x}$	s	w
93	84.35	2.79	76-96	11	95	85.20	2.56	78-92
162	84.88	2.75	77-92	12	142	86.54	2.54	81-93
149	85.00	2.94	75-91	13	151	87.41	2.74	81-95
165	86.69	2.84	79-94	14	139	87.97	2.93	79-95
99	87.41	3.14	79-98	15	156	88.06	2.89	80-97
57	87.75	3.14	81-96	16	147	88.03	2.87	82-100
58	88.32	3.18	82-97	17	139	88.34	2.62	81-96
47	88.89	2.95	82-96	18	114	88.14	2.66	81-94
830					1083			

Conclusions

The measured parameters clearly show a tendency to increase with age in the given samples. The changes in the dimensions of the head and face only partly run in parallel with the changes in body size.

The sex differences tend to favour the boys, but with exceptions relating to the earlier sexual maturity of the girls and the acceleration at puberty. The head and face dimensions of the boys finally tend to outstrip those of the girls, whose heads remain smaller and more gracile.

Changes in the head and face dimensions are slow after the age of 10 years, by which time they have attained 96% of the adult dimensions. The averages for these Nógrád children appear to fit in well with the Hungarian standards.

References

FARKAS, GY. (1990): Serdülés és környezet. - JATE Press, Szeged,124 pp.

FARKAS, L. GY. (1996): Fejezetek a biológiai antropológiából. I-II.- JATE Press, Szeged.

FARKAS, GY. and NYILAS, K. (1988): Head measurement parameters at 23338 to 18-years-old Hungarian children. - Acta Biol. Szeged. *34*, 139-153.

FARKAS, GY. and NYILAS, K. (1996): Characteristics parameters of head measurements in Hungarian children aged 3-18 years. - Acta Biol. Szeged. *41*, 73-82.

MARTIN, R. and SALLER, K. (1956): Lehrbuch der Anthropologie. Bd.1. - Stuttgart, 323-343 pp.

TANNER, J. M. - HIERNEAUX, J. and JARMAN, S. (1969): Growth and phisique studies. In: WEINER, J. S. and LOURIE, J. A. (eds): Human Biology. A guide to Fields Methods. Bp.Handbook. No.9. - Blackwell Sceintific Publ., Oxford-Edinburgh.

ACTA BIOL. SZEGED. 42, pp. 271-278 (1997)

TRAIT VARIATIONS IN CHILDREN AS INDICATORS. PRELIMINARY DATA OF A RESEARCH PROJECT

M. PAP, GY. SZABÓ, and T. GÖNCZI-SZABÓ*

Department of Human Biology , L.Kossuth University, Debrecen H-4010, P.O.B. 6 , Hungary;
**Bessenyei Teachers' Training College, Department of Biology, Nyíregyháza H-4401 P.O.B. 166, Hungary*

(Received: December 10, 1996)

Abstract

The study reports some preliminary results within the research project "Population biological criteria of human populations and the various environmental impacts" from examinations on children in the Bódva valley (North Hungary, Borsod-Abauj-Zemplén County). It documents the physical development of 340 Hungarian and Gypsy children aged 7-15 years from the Bódva microregion, which is regarded as relatively homogeneous from a human ecological point of view.

Key words: metrical character variations of children, Bódva microregion, Hungarian and Gypsy samples, interpopulational analysis.

Introduction

Determination and control of the changes in the sociodemographic, genetic structures and the biological status of human populations are indispensable in an exploration of the factors influencing the state of health of the various populations. A whole series of examinations prove that the life style, the dwelling place, the place of work and the natural and social environment considerably influence the health and biological status of the population.

The notoriously unfavourable health state of the Hungarian population is overwhelmingly due to widespread, non-infectious, degenerative diseases, accidents and somatic, psychic and social states, underlying which are new types of causes, risk factors and numerous other problems (KERTAI, 1993; BOJÁN et al., 1993).

A population-biologically oriented approach to the changes in the sociodemographic structure and the genetic stock of human populations requires new scientific results (HARRISON and BOYCE, 1972; WALTER and NEMESKÉRI, 1972; FREIRE-MAIA, 1974; PAP, 1979, 1986; CRAWFORD et al., 1987), which are indispensable for a complex interpretation of urbanization, social restratification, transformation of life style and the changes caused by the natural and social environment for the preservation of the population's health and fitness for work.

Theoretically, our point of departure is the basic statement that individuals (as "unique information carriers") consistently differ from one another in their geno- and phenotypes, and hence in their responses to environmental impacts. Furthermore, we presume that the properties of the individuals, and the quantitative and qualitative variations of their traits are reflected in selected samples, and can be well interpreted at the individual, age group, population and microregion levels (PAP, 1984; PAP et al., 1996).

We plan an exploration of the causal and background variables underlying the characteristic biological, sociodemographic criteria observed and the expression of the complex phenomena with quantitative variables, as well as the establishment of a new database.

Our research project and the results are intended to provide further information for a nationwide monitoring of the biological status of the various populations (GYENIS and SZERÉNYINÉ, 1984; BODZSÁR, 1984; EIBEN and PANTÓ, 1986; FARKAS, 1986).

Here, we present an account of investigations carried out within the above research project, of some variations of traits in children, based on an intrapopulational analysis.

Material and method

A study was made of the physical development, biological state and sociodemographic status of children living in the populations of a North-Hungarian microregion (the Bódva valley), the given natural and social environment being taken into account. Eight metrical characters of 340 children were selected [stature (M.1), weight (M.71), biacromial diameter (M.35), bicristal width (M.40), iliac spine height (M.13), shoulder height (M.8), sitting height (M 23) and transverse chest breadth (M.36)], and analyses were carried out on these data. In the course of the examinations, MARTIN's prescriptions (MARTIN and SALLER, 1957-66) were followed, and consideration was given to the IBP recommendations (TANNER et al., 1969). The number of subjects involved in the three samples: Hungarians at Bódvaszilas 104 persons (50 boys and 54 girls), Hungarians at Szalonna 93 persons (41 boys and 52 girls), and Gypsy children at Bódvaszilas + Szalonna 143 persons (76 boys and 67 girls). The three samples account for 35 % of the children in this age group /7-15 yr/ in the Bódva microregion (1990 census). For the comparative analysis, 4 combined age groups were formed: 1) 7-8 yr, 2) 9-11 yr, 3) 12-13 yr and 4) 14-15 yr. Data processing and the analyses were performed with the SPSS/PC$^+$ program packet.

Results and discussion

The preliminary results of these monitoring examinations will be used primarily to test the concept of our research, with regard to the fact that the children were examined as unique information carriers in the given population and microregion. Prominence was therefore given to the procedures that help reveal the individual properties and parameters at any time and by which the specificities can be well studied. The set of information manifested at the individual, population and microregion levels can be interpreted within further relations (e.g. obesity or goiter disease).

The microregion classification of the cadastral survey of the small landscapes of Hungary (MAROSI and SOMOGYI, 1990) made sampling and hence the reliability of the material used in the study more consistent. We have succeeded in solving the problem caused by the small number of 7-15- yr olds in the Bódva valley "small populations". With an examination method considering the whole of the microregion, the migration effects can be treated as well. This is an especially important circumstance as concerns the Gypsy children.

The distribution of the variables was analysed in several steps. Comparisons of the absolute metrical characters by sex, age groups and populations are presented in Tables 1-4. As regards the analyses with the t-test (LEVENE's test) included in these Tables, for reasons of space we report only on the age groups for which the sex distribution of the traits differed significantly. First, we give the results for the various age groups of the Hungarian children. In the first age group, a significant difference was not found in any case, while in the second age group there was a difference only in transverse chest breadth. On the other hand, in the third age group (12-13 yr) the differences between the mean values were significant in five traits. The length and weight values for the girls showed considerable increase (Table 1).

Table 1. Descriptive statistics on body measurements of Hungarian boys and girls in the Bódva valley (age group III).

Variables	Sex	Mean	SD	SE of mean	Mean differ.	LEVENE's test	T-value	2-Tail sig.
Stature	Boys Girls	152.6933 159.6619	10.428 7.424	2.692 1.580	-6.9686	F=2.166 P=.150	-2.37	0.024
Weight	Boys Girls	39.6000 48.7619	7.590 8.902	1.960 1.943	-9.1619	F=.252 P=.619	-3.23	0.003
Biiliocrist diameter	Boys Girls	24.1333 26.5429	2.270 2.124	0.586 0.463	-2.4095	F=.202 P=.656	-3.26	0.003
Sitting height	Boys Girls	78.8733 83.1905	5.448 3.834	1.407 0.837	-4.3171	F=.791 P=.380	-2.80	0.008
Shoulder height	Boys Girls	122.8333 129.1667	8.648 7.079	2.233 1.545	-6.3333	F=.555 P=.461	-2.41	0.021

Table 2. Descriptive statistics on body measurements of Hungarian boys and girls in the Bódva valley (age-group IV).

Variables	Sex	Mean	SD	SE of mean	Mean differ.	LEVENE's test	T-value	2-Tail sig.
Stature	Boys Girls	168.8471 162.0292	10.051 6.591	2.438 1.345	6.8179	F=3.050 P=.089	2.63	0.012
Weight	Boys Girls	53.4118 49.7708	9.790 7.752	2.375 1.582	3.6409	F=1.214 P=.277	1.33	0.192
Biacromial diameter	Boys Girls	35.6647 34.0292	3.032 1.793	0.735 0.366	1.6355	F=2.115 P=.154	2.17	0.036
Iliac sp. height	Boys Girls	97.8059 90.8833	5.893 6.363	1.429 1.299	6.9225	F=.162 P=.689	3.54	0.001
Shoulder height	Boys Girls	138.2588 131.7917	8.600 5.308	2.086 1.083	6.4672	F=3.108 P=.086	2.98	0.005
Transverse chest	Boys Girls	26.1059 24.1667	4.077 1.774	0.989 0.362	1.9392	F=1.805 P=.187	2.08	0.044

In the fourth age group (Table 2) the differences between the sexes were similarly demonstrable: significant differences were found in the mean values of stature, biacromial diameter, iliac spine height, shoulder height and transverse chest breadth. However, as compared with the third age group, the metrical characters were larger for the boys; thus, the situation was just the reverse.

In the various age groups of the Hungarian and Gypsy children, the tendencies prevailing in the distribution of the trait variations were examined in the comparison of the sexes (Tables 3 and 4.). In the first age group of the boys, there were no significant differences between the mean values, while in the second age group, the differences were significant ($p<0.05$) in two cases (stature and sitting height). In the third age group, there was no difference, whereas in the fourth group, significant differences were found in four length characters (Table 3). The mean values for the Hungarian boys were higher.

Table 3. Descriptive statistics on body measurements of Hungarian and Gypsy boys in the Bódva valley (age group IV).

Variables	Population	Mean	SD	SE of mean	Mean differ.	LEVENE's test	T-value	2-Tail sig.
Stature	Hungarian Gypsy	168.8471 160.4100	10.051 9.551	2.438 3.020	8.4371	F= .031 P= .861	2.14	0.042
Weight	Hungairan Gypsy	53.4118 48.8500	9.790 10.236	2.375 3.237	4.5618	F= .090 P= .766	1.15	0.261
Iliac sp. height	Hungarian Gypsy	97.8059 90.5800	5.893 6.135	1.429 1.940	7.2259	F= .000 P= .986	3.03	0.006
Shoulder height	Hungarian Gypsy	138.2588 130.1900	8.600 8.291	2.086 2.622	8.0688	F= .000 P= .999	2.38	0.025

Table 4. Descriptive statistics on body measurements of Hungarian and Gypsy girls in the Bódva valley (age-group III).

Variables	Population	Mean	SD	SE of mean	Mean differ.	LEVENE's test	T-value	2-Tail sig.
Stature	Hungarian Gypsy	159.6619 151.2250	7.242 6.743	1.580 1.686	8.4369	F= .049 P= .827	3.62	.001
Sitting. height	Hungarian Gypsy	83.1905 77.9375	3.834 3.387	.837 .847	5.2530	F= .411 P= .526	4.34	.000
Iliac sp. height	Hungarian Gypsy	91.4429 86.6187	5.201 4.532	1.135 1.133	4.8241	F= .019 P= .891	2.95	.006
Shoulder height	Hungarian Gypsy	129.1667 122.3250	7.079 6.010	1.545 1.503	6.8417	F= .114 P= .738	3.10	.004

Conversely, demonstrable differences were found between the trait variations of Hungarian and Gypsy girls in all four age groups. Significant differences were observed in the first age group in stature and shoulder height ($p<0.05$ for both), in the second age group in stature and sitting height ($p<0.01$ for both), and in the third age group in stature, sitting height, shoulder height and iliac spine height ($p<0.01$ for all). This descriptive statistical result is presented in Table 4. Finally, in the fourth age group, considerable differences between the traits of the Hungarian and Gypsy girls were demonstrated in the distribution of three traits: stature, shoulder height and sitting height ($p<0.01$). The higher mean values, as for the boys, were found for the Hungarian girls.

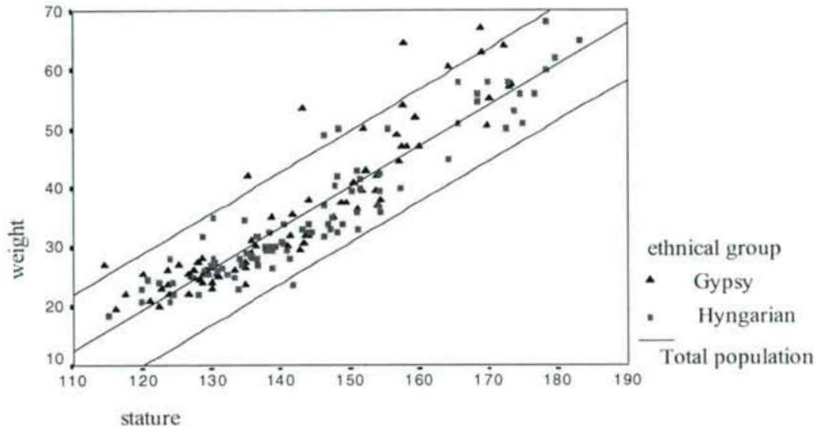

Fig. 1. Linear regression of stature vs. weight for boys in the Bódva valley (all age groups).

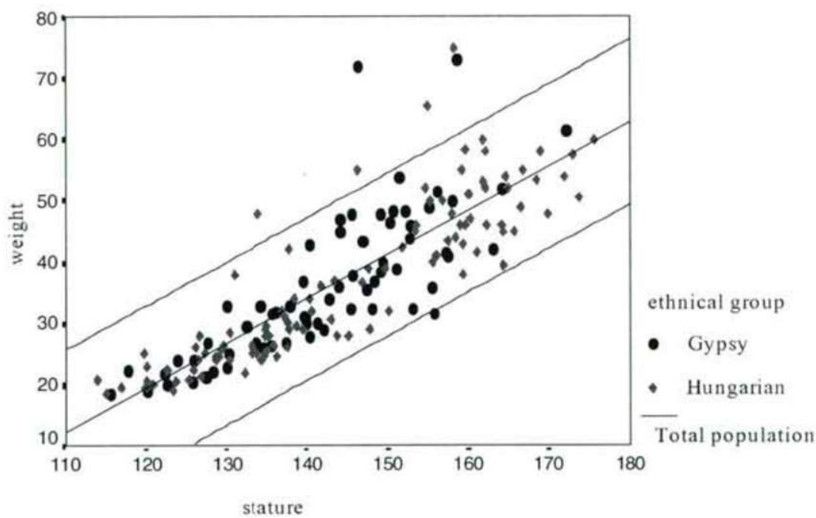

Fig. 2. Linear regression of stature vs. weight for girls in the Bódva valley (all age groups).

Correlating the above results and following BLOM's method (see program packet), the stature vs. weight linear regression is presented for all age groups of boys (Fig. 1) and girls (Fig. 2) in the three samples from the Bódva valley. The relationships and the dispersion of the traits of Hungarian and Gypsy boys and girls can be surveyed together. The linear regression analysis reveals that the gradients of the lines are positive in every case, i.e. the regression coefficient is positive. The gradient differs significantly from zero. There is a close connection between the two variables (Table 5 and 6). Attention is drawn to the cases outside the 95% confidence interval zone, in which a considerable excess weight was found (Figs 1 and 2). Since the program packet permits inclusion of the individuals' code numbers, the relation of the quantitative and qualitative variables at the level of the individuals can be learnt. In this way, we have increased opportunities to identify the background variables and the cause vs. effect relations.

Table 5. Regression analyis of some body measurements versus stature for boys (Hungarians=1; Gypsies=2; Y'= mx + b).

Body measurements		m	b	r	R
Bicristal width	1	0.15	0.93	0.923	0.852
	2	0.15	1.84	0.753	0.567
Iliac spine height	1	0.66	-15.30	0.947	0.897
	2	0.64	-10.78	0.966	0.933
Shoulder height	1	0.89	-13.92	0.993	0.985
	2	0.87	-9.74	0.983	0.967
Transverse chest breadth	1	0.16	-1.66	0.777	0.603
	2	0.16	-0.20	0.795	0.632
Biacromial diameter	1	0.21	0.61	0.903	0.815
	2	0.22	0.51	0.894	0.799
Sitting height	1	0.44	11.14	0.968	0.936
	2	0.46	9.27	0.964	0.929
Weight	1	0.64	-61.68	0.936	0.876
	2	0.73	-68.19	0.909	0.826

Table 6. Regression analyis of some body measurements versus stature for girls (Hungarians=1; Gypsies=2; Y'= mx + b).

Body measurements		m	b	r	R
Bicristal width	1	0.19	-4.69	0.866	0.751
	2	0.21	-6.70	0.816	0.665
Iliac spine height	1	0.63	-9.31	0.971	0.942
	2	0.66	-14.26	0.917	0.840
Shoulder height	1	0.89	-13.74	0.978	0.957
	2	0.85	-6.88	0.988	0.977
Transverse chest breadth	1	0.16	0.51	0.830	0.689
	2	0.18	-4.44	0.789	0.623
Biacromial diameter	1	0.20	2.31	0.886	0.786
	2	0.25	-3.81	0.878	0.772
Sitting height	1	0.48	5.41	0.963	0.927
	2	0.45	9.94	0.950	0.903
Weight	1	0.71	-65.57	0.877	0.769
	2	0.77	-73.88	0.793	0.629

For further determination of the distributions, we made use of the indices relating to the central point and standard deviation of the samples. The localization of the sample is characterized by the median and its dispersion, with the interquartile range. The median is the resistant measure of the sample's centre and is suitable for characterizing the central point of asymmetric distributions. In our opinion the quartile (boxplot) figure can be successfully applied to the parametric tests too. A detailed presentation of our analysis would go beyond the scope of this study. We confine ourselves here to an analysis of the distribution of stature on the basis of the data for the Hungarian children in the Bódva valley (Fig. 3). This procedure allows a selection on the basis of various traits, of the cases outside the interquartile region, i.e. the extreme occurrences. Thus, the result obtained by linear regression was confirmed with a different method.

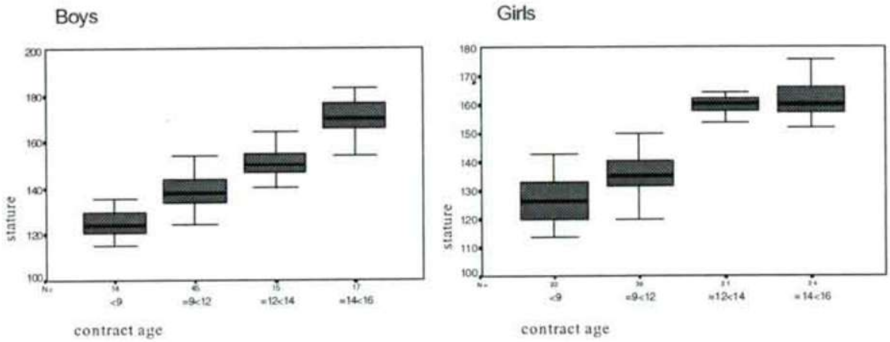

Fig. 3. Changes in stature of Hungarian children (boxplot).

Conclusions

The population-biological approach to changes in the sociodemographic structure and the genetic stock of human populations requires new scientific results, which are indispensable for a complex interpretation of the changes caused by the natural and social environment, for the conservation of the health and fitness for work of the population. Our new data (database) obtained through the human biological examination of 7-15-yr-old children may serve as an important part of a nationwide monitoring research. We have presented some important elements of the concept of our research, awaiting confirmation, complementation or refutation. Our working hypothesis is: that the Bódva microregion provides a relatively homogeneous ecological system of conditions, where well-definable natural factors affect the human populations and, within this frame, the children in the 7-15-yr age group. These factors influence the development of the biological state of the children. The trait variations of the children were analysed in several steps. Analysis by age groups and sexes can well demonstrate the characteristics of prepuberty– puberty and also the developmental differences of the members of the different ethnic groups.

Acknowledgement

This study was supported by the National Scientific Research Foundation (OTKA grant no. T 016110).

References

BODZSÁR, É. B. (1984): Gyermekek szomatokonstrukciója és ökológiai összefüggésük közép-dunántúli falvakban. - ELTE, Budapest (CSc. thesis).

BOJÁN, F., MCKEE, M. and OSTBY, T. (1993): A népességtan oktatásának fejlesztése Magyarországon. Tempus project structúrája. - Népegészségügy *74*, 93-99.

CRAWFORD, M., PAP, M., and KOERTVELYESSY, T. (1987): Hungarian family expedition briefing. - Earthwatch, Boston *1*, 140 pp.

EIBEN, O. G. and PANTÓ, E. (1986): The Hungarian national growth standards. - Anthrop. Közl. *30*, 5-23.

FARKAS, GY. (1986): Délalföldi 10-18 évesek testi fejlettsége és a leányok menarchekora. - Budapest (DSc. thesis).

FREIRE-MAIA, N. (1974): Populations genetics and demography. - Human Heredity *24*, 105-113.

GYENIS, GY. and SZERÉNYINÉ PÁSZTOR, ZS. (1984): Érd'79. Az érdi iskolásgyermekek testi fejlettsége. - Humanbiol. Budapest. Suppl. *2*, 143 pp.

HARRISON, G. A. and BOYCE, A.J. (1972): The structure of human populations. - Clarendon Press, Oxford.

KERTAI, P. (1993): A népegészségügy prioritásai Magyarországon az ezredfordulóig. - Népegészségügy *74*, 133-156.

KOERTVELYESSY, T., PAP, M. and SZILÁGYI, K. (1987): The mating structure of four agriculturalist villages in NE Hungary. - American J. Physical Anthrop. *72*, 220.

MAROSI, S. and SOMOGYI, S. (eds) (1990): Magyarország kistájainak katasztere II. - MTA Földrajztudományi Kutató Intézet, Budapest.

PAP, M. (1984): A humán populációgenetikai kutatás néhány aspektusa a magyarországi vizsgálatok tükrében. - Anthrop. Közl. *28*, 84-89.

PAP, M. (1979): Some aspects of populations structure and genetic variability in the Tiszamogyorós population in Hungary. - Acta Biol. Debr. Suppl. *1*, 1-103.

PAP, M. (1986): Polymorphism of red cell enzymes, heterozygosity and population structure. - Coll. Anthrop. *10*, 49-52.

PAP, M.T., SZABÓ, GY. and GÖNCZY-SZABÓ, T. (1996): Populationbiological feature of human populations, physical development of children and environmental effects. - 10th Congress of the European Anthropological Association, Brüssels, Program Abstracts 54 pp.

TANNER, J. M., HIERNAUX, J. and JARMAN, S. (1969): Growth and physique studies. In: WEINER, J. S. and LOURIE, J. (eds): Human biology. A guide to field methods. - IBP Handbook. Blackwell Sci. Publ. Oxford, Edinburgh. No. 9. 76 pp.

WALTER, H. and NEMESKÉRI, J. (1972): Population genetic investigations in the Bodrogköz area of NE Hungary. In: TÖRŐ, J., SZABADY, E., NEMESKÉRI, J. and EIBEN, O. G. (eds): Advances in the biology of human populations. - Akadémiai Kiadó, Budapest, 329-343 pp.

1990. évi Népszámlálás (1992): Borsod-Abaúj-Zemplén megye adatai. - Központi Statisztikai Hivatal 7., Budapest.

ACTA BIOL. SZEGED. 42, pp. 279-285 (1997)

ADOLESCENT GROWTH OF TRUNK MEASUREMENTS IN ATHLETIC BOYS

J. PÁPAI

Central School of Sports, H-1443 Budapest, P. O. Box. 130, Hungary

(Received: December 10, 1996)

Abstract

Peak velocities (PVs) in trunk measurements were studied in 41 athletic boys. The children were followed up for at least for 5 yr from an initial age ranging between 10 and 12 yr. The measurements were taken at 6-month intervals. The studied variables were shoulder, chest and hip width and chest depth. The graphical method was applied to estimate the timing and magnitude of PVs. To assess the progress of maturation, Tanner's stages of genital development (TANNER, 1962) and first ejaculation time (spermarche) were used. To determine the relationship between the ages at PV and maturity characters, linear correlations were calculated.

Means PVs were 14.01, 14.21, 14.37 and 14.40 yr for hip width, chest depth, chest widht and shoulder width, respectively. A considerable proportion of the children displayed unimodal velocity curves. In the others, the curves were bimodal. Single peaks were consistently earlier in timing and higher in magnitude.

All velocity peaks occurred in stage G4 of sexual maturation. Ages at PV and on entry into G4 and G5 were positively related. Relations with the spermarche were also positive, but looser.

Key words: peak velocity, maturation, trunk measurements.

Introduction

In Hungary, there have been a number of longitudinal studies dealing with the rapid changes in somatic growth during the adolescent period (HEGEDÜS and SZÉKELY, 1968; BAKONYI et al., 1969; RAJKAI, 1970; SZÖLLŐSI, 1982; SZÖLLŐSI and JÓKAY 1991; VARGHA et al.,1991), and some that also include the progress of sexual maturation and its relation to body build (PÁPAI and BODZSÁR, 1986; PÁPAI and SZABÓ, 1986; BODZSÁR and PÁPAI, 1989; EIBEN et al., 1992).

So far, however, little attention has been paid to the growth and biological development of athletic children (PÁPAI et al., 1991; 1992; SZABÓ et al., 1991; PÁPAI and SZABÓ, 1996) in this respect. The potential effect of selection (and hard physical training) on the timing and magnitude of intense growth and the process of sexual maturation is a most interesting one.

This paper is the second of a series dealing with questions of pubertal growth and maturation. The first study (PÁPAI and SZABÓ, 1996) was devoted to the examination of the characteristics of peak velocities (PVs) in some longitudinal measurements (height, sitting height and lower extremity). This work concentrates on trunk breadth measurements.

The purposes were:

1. to estimate the timing and extent of the peaks of the adolescent growth spurt in four torso breadths: shoulder, chest and hip widths and chest depth;

2. to observe sexual maturation signs at the respective PVs of these dimensions;

3. to study the interrelations of somatic growth and its connections with maturation;

4. to establish whether different sports disciplines exhibit differences in these parameters.

Material and methods

The subjects were 41 boys active in various sports at the Central School of Sports. The follow-up study started from an initial age ranging between 10 and 12 yr and was repeated for at least 5 yr. The measurements were taken at 6-month intervals, in spring and autumn.

Special interest was devoted to the ages at maximum growth velocity and the amplitude of the peak for the four trunk measurements. The measurements were as follows: shoulder width (biacromial diameter), chest width (transverse chest), hip width (biiliocristal diameter) and chest depth (antero-posterior chest).

Maximum yearly increments and ages at these peaks were assessed graphically from the individual growth curves obtained by linear interpolation. The shapes of the curves were also analyzed.

Advance in sexual maturation was estimated by TANNER's rating (1962) of genital stages. Data were also collected by a prospective method for the time of the first ejaculation, spermarche.

Only basic descriptive statistics and correlations are presented. The differences in the groups of boys participating in different sports disciplines were tested by the F-test at 10% after one-way Anova.

Results and discussion

The ages at peak were very close to one another (Table 1). The timing and the succession of peaks demonstrated that the rapid broadening in the different trunk regions occurred occurred in a short time interval.

Our data were in good agreement with the results of the HARPENDEN study (TANNER et al., 1976) and were also close to the data of BUCKLER's (1990) study. Those authors found that the shoulder width lagged behind the hip width. In the present material, this difference was 0.4 years. BEUNEN et al. (1988) observed a later median age at peak for both variables in Belgian boys.

Table 1. Parameters of PVs of athletic boys (n=41).

	Shoulder width		Chest width		Hip width		Chest depth	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age at PV (yr)	14.40	1.08	14.37	1.12	14.01	1.02	14.21	1.08
PV (cm/yr)	2.57	0.47	1.93	0.52	1.62	0.35	1.43	0.34

The mean age at peak followed a definite order: the earliest spurt was experienced in the hip region, followed by the intense growth in chest depth, and the latest spurt was observable in the chest and shoulder widths.

When the ages at PV were compared with those in the length measurements (PÁPAI and SZABÓ, 1996), the intense growth in hip width was found almost to coincide with the timing of the peak in the lower extremity (13.94±1.07 yr) and occurred quite close to that for height (14.13±0.91 yr). Simultaneously, the mean age at maximum annual increment for shoulder width was observed earlier than the time at peak in sitting height (14.52±1.00 yr), though they were also close to each other.

The earlier growth spurt in the hip width may be connected with the relatively early lengthening of the lower extremity, contributing to the stabilization of the growing body and the bearing of the increasing body mass.

As regard the timing of the other studied maximum velocities, TANNER (1962) found that the age at PV in chest width coincided with that in hip width, while the intense growth in chest depth occurred at the same mean age as the spurt in sitting height.

Although the succession of the timing of the peaks in our material exhibited a somewhat different pattern from those found in other studies (TANNER, 1962; TANNER et al., 1976; HAUSPIE, 1980; BEUNEN et al., 1988; BUCKLER, 1990; MALINA and BOUCHARD, 1991), the ages at PV fell into the range of these references.

The differences in the timing of the ages at PV for trunk diameters partly reflect the differences in the methods of estimation (MALINA and BOUCHARD, 1991), and are partly due to the greater difficulty in determining the growth spurt for trunk dimensions (HAUSPIE, 1980).

The maximum yearly increment was the largest for the shoulder width and the smallest for the chest depth. When our data were compared with those of others (TANNER, 1962; TANNER et al., 1976; BEUNEN et al., 1988), the means of the respective PVs were slightly smaller in the above-mentioned studies.

Simultaneously, the variability in the magnitude of PVs was slightly greater in our sample. The higher SD can be partly explained by the fact that our boys participated in dissimilar sports disciplines and it is a well-known fact that the various disciplines prefer different body structure. On the other hand, the greater variability may originate from the differences in the techniques applied.

In respect of the shapes of the curves, it is worth noting that for the hip width and chest depth one-third of the children displayed bimodal velocity curves, while in the shoulder and chest widths the proportion of bimodal curves was close to 50%. The timing of the single peaks was consistently earlier and peak velocities were higher. In the boys displaying bimodal velocity curves, the difference between the two modes was about 2 yr, and the later peak usually had the greater magnitude.

ASHIZAWA (1994) studied the velocity curves for height for girls and separated three types of individual curves. She found that 75% of the girls presented one peak, while 23% displayed two peaks. Our data also indicate that both the intra- and the interindividual growth rate varies greatly during the adolescent period, and demonstrate that the acceleration and deceleration in body measurements may follow different pathways. This point needs further investigation.

Table 2. Correlations between the parameters of PV of the examined variables.

	Shoulder width	Chest width	Hip width	Chest depth
Shoulder width	-	0.76	0.54	0.53
Chest width	0.30	-	0.62	0.52
Hip width	0.11	0.02	-	0.67
Chest depth	0.09	0.17	0.22	-

Above the diagonal: age at PV(yr).
Below the diagonal: PV (cm/yr). r39.5% = 0.30

Table 2 contains the coefficients for the age and amplitude at PV. The ages at the respective velocity maxima showed a positive but moderate correlation. The only close connection was found between the age at peak of the chest and shoulder breadths. The three PV amplitudes were unrelated (subdiagonal part of Table 2).

TANNER et al. (1976) also found a close connection between the ages at PV, and no correlation between the amplitudes for shoulder and hip widths.

The progress in sexual maturation was characterized by the mean age of spermarche and the age of entering different stages of genital maturation (Table 3). Some of the boys were in genital stage 3 at the outset, so we could only determine the ages when all boys entered stages 4 and 5.

Data for the time of spermarche have previously been collected from different regions of Hungary (DEZSŐ, 1965; EIBEN and PANTÓ, 1984; EIBEN et al., 1992; PÁPAI, 1992). In the national sample (EIBEN and PANTÓ, 1986), the median value was 14±0.19 yr. PÁPAI et al. (1994) reported a similar median age in a cross-sectional sample of athletic boys. In the Budapest longitudinal study (EIBEN et al., 1992), spermarche occurred at the median age of 13.3 yr when the genital development was between stages 3 and 4. The mean age at spermarche in our athletic boys was found to be lagging almost 1 yr behind that of Budapest boys. The succession of events also differed, as in our sample spermarche occurred in the first third of stage G4.

Table 3. Parameters of maturity variables.

Critical ages	Mean	SD
Age at spermarche (yr)	14.17	0.76
Age on entering G4 (yr)	13.70	0.79
Age on entering G5 (yr)	14.95	0.95

G4-G5: genital stages of sexual development.

All the ages at PV fell into the second third of stage G4. TANNER et al. (1976) reported a similar sequence of maturation and somatic events, though in their study the age at entering G4 and G5 was about 0.3 yr earlier than in our material.

Table 4 demonstrates that the age at PV was poorly and negatively related to the extent of PV for shoulder width and chest depth. No relationship was found for chest and hip widths in this respect. TANNER et al. (1976) also reported the absence of a correlation between PV amplitude and age at PV for both shoulder and hip widths.

Table 4. Correlations between growth and maturity parameters.

Correlates	Shoulder width	Chest width	Hip width	Chest depth
Age at PV and PV	-0.44	-0.10	-0.22	-0.44
Age at SA and age at PV	0.34	0.40	0.27	0.43
Age at G4 and age at PV	0.70	0.72	0.65	0.72
Age at G5 and age at PV	0.70	0.71	0.57	0.57

PV: (cm/yr) SA: Spermarche G: Genital stage
r39.5% = 0.30

The correlation between the age at spermarche and age at PV was loose. On the other hand, we found a quite close relationship between the timing of stages G4 and G5 and of the peaks. The morphogenetic and sexual effects of the sexual hormones, known to rise steeply after stage G3 (WINTER, 1978), appeared to dissociate less than the sexual ones proper, such as spermarche and G4.

Table 5. Age at PV of boys taking part in different disciplines.

	Shoulder weight		Chest weight		Hip weight		Chest depth	
Events	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cycling (N=9)	13.77	1.23	13.72	1.20	13.75	0.75	13.74	0.99
Pentathlon (N=9)	14.24	0.87	13.99	0.53	13.18	0.78	13.90	1.18
Tabletennis (N=6)	14.68	0.60	14.55	1.48	13.92	0.88	14.34	1.00
Gymnastics (N=7)	15.31	1.16	15.48	0.66	15.03	0.60	14.93	1.00

Table 5 displays the age at PV for the various sports events. The timing of the peaks followed the sequence displayed for the grand means of the sample (Table 1). The cyclists were the only exception, in that they all had their ages at maximum velocity at the same time and showed a rather early PV age in general. Gymnasts were the oldest in showing PV in trunk dimensions. Maturation signs occurred the earliest in the cyclists and latest in the gymnasts.

In the case of the chest depth, the mean ages at maximum velocity were similar to one another, while in the other measurements significant differences were found between the timing of the peaks. The cyclists had the earliest growth spurt, and the gymnasts the latest one.

The means of maximum yearly increments (Table 6) were similar for the groups, without any significant difference.

Table 6. PVs of boys taking part in different disciplines.

	Shoulder width		Chest width		Hip width		Chest depth	
Events	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cycling (N=9)	2.83	0.70	2.08	0.56	1.77	0.27	1.46	0.24
Pentathlon (N=9)	2.51	0.41	1.75	0.30	1.60	0.38	1.43	0.43
Tabletennis (N=6)	2.49	0.40	1.85	0.47	1.77	0.17	1.39	0.17
Gymnastics (N=7)	2.26	0.34	2.36	0.70	1.38	0.35	1.52	0.50

It is of interest that the gymnasts experienced the latest maturation and the latest ages at peak in the examined transversal body dimensions. Similar results were obtained for the longitudinal measurements (PÁPAI and SZABÓ, 1996). Gymnasts undergo selection not only for sport skills, but also for physique. Delayed growth in both the somatic characters and maturation is an advantage in this sport. It was impossible to decide from these data whether this definitely late puberty was due to physical retardation, long-term physical work or both.

Conclusions

1. The timing of the peaks of adolescent growth spurt exhibited a definite sequence in the four trunk measurements and they were positively interrelated. The correlation coefficients displayed a moderate relationship.

2. The observed amplitude of the peaks and the SD's were larger than in other studies. These differences are due partly to the different techniques used, and partly to the composition of the present sample (the children represented different disciplines).

3. The study of the shape of individual velocity curves revealed that the acceleration of the growth in trunk dimensions may follow different patterns. Approximately 50% of the children displayed unimodal curves as concerns the shoulder and chest widths, and two-thirds of them showed the same phenomenon in chest depth and hip width. Single peaks were consistently earlier in timing and higher in amplitude.

4. The signs of sexual maturation were also related. Spermarche occurred in the early phase of stage G4. All the peaks of the studied variables fell within this stage, too. The timing of the peaks and maturation characteristics revealed that the stages of sexual development were in a closer connection with the transversal growth of the trunk than the spermarche.

5. The question of whether sports have any specific effect on adolescent growth is hard to answer. There were certain differences between the groups of events in the timing of the peak. It is a problematic task to explain these minor differences, because individuals may vary markedly within the same group. Further, selection for discipline and physique could conceal the possible effects of long-term training.

References

ASHIZAWA, K. (1994): TW2 skeletal maturation, growth and age at menarche in Tokyo girls. - Auxology '94. Humanbiol. Budapest. *25*, 261-265.

BAKONYI, F., EIBEN, O., FARKAS, Gy., and RAJKAI, T. (1969): Tíz-tizenkilenc éves városi gyermekek növekedése az 1962-65. években végzett longitudinális vizsgálat alapján. - Anthrop. Közl. *13*, 143-168.

BEUNEN, G. P., MALINA, M. M., VAN'T HOF M. A., SIMONS J., OSTYN, M., RENSON, R. and VAN GERVEN, D. (1988): Adolescent Growth and Motor Performance. A Longitudinal Study of Belgian Boys. - Human Kinetics, Champaign. 102. pp.

BODZSÁR, É. B. and PÁPAI, J. (1989): Maturation and body composition. - Humanbiol. Budapest. *19*, 215-218.

BUCKLER, J. (1990): A Longitudinal Study of Adolescent Growth. - Springer, London - Berlin - Heidelberg - New York - Paris - Tokyo - Hong Kong.

DEZSŐ, Gy. (1965): Budapesti fiúk gonád-érésének időpontja. - Anthrop. Közl. *9*, 151-156.

EIBEN, O. G., FARKAS, E., KÖRMENDY, I., PAKSI, A., VARGA TEGHZE-GERBER, Zs. and VARGHA, P. (1992): A budapesti longitudinális növekedésvizsgálat 1970-1988. (The Budapest Longitudinal Growth Study 1970-1988). - Humanbiol. Budapest. *23*.

EIBEN, O. G. and PANTÓ, E. (1984): Adatok városi és falusi fiúk oigarchekorához (Preliminary data for the age at oigarche of urban and rural boys in Hungary). - Anthrop. Közl. *28*, 193-194.

HAUSPIE, R. (1980): Adolescent growth. In: JOHNSTON, F. E., ROCHE, A. F. and SUSANNE, C. (eds): Human Physical Growth and Maturation. - Plenum Press, New York and London. 161-175 pp.

HEGEDŰS, Gy. and SZÉKELY, A. (1968): A testi fejlődés dinamikus vizsgálatából leszűrt néhány törvényszerűség. - Anthrop. Közl. *12*, 5-12.

MALINA, P. M. and BOUCHARD, C. (1991): Growth, Maturation and Physical Activity. - Human Kinetics, Champaign. 251-272 pp.

PÁPAI, J. (1992) Jászsági 7-14 éves gyermekek növekedése, testi fejlődése és fizikai teljesítménye (Growth, development and physical performance of Jászság children aged 7-14, in Hung.). - Ph.D. thesis, ELTE, Budapest.

PÁPAI, J. and BODZSÁR, É. (1986): Sexual maturation in urban girls. - 7th Internat. Anthropol. Poster Conference, Zagreb, 15-19 pp.

PÁPAI, J., BODZSÁR, É. B. and SZABÓ, T. (1994): Mass fractions, somatotype and maturity status in athletic boys. Auxology '94. - Humanbiol. Budapest. *25*, 515-519.

PÁPAI, J. and SZABÓ, T. (1986): The physique of urban girls. - Anthrop. Közl. *30*, 221-225.

PÁPAI, J. and SZABÓ, T. (1996) Pubertal growth and maturation in athletic boys. In: SZABÓ, T. and MÉSZÁROS, J. (eds): 2nd International Round-Table Conference on Sports Physiology (in press).

PÁPAI, J., SZABÓ, T. and SZMODIS, I. (1992): Age trends in the fractional body composition of athletic and non-athletic boys. In: SZABÓ, T. and MÉSZÁROS, J. (eds): 2nd International Round-Table Conference on Sports Physiology (in press).

PÁPAI, J., SZMODIS, I. and SZABÓ, T. (1991): The estimation of body composition by Drinkwater's method of fractionation in children - First observations. In: FARKAS, Gy. L. (ed.): Papers of the Scientific Session in Szeged (Hungary). - JATE Univ., Ulm, Szeged - Ulm, 215-224 pp.

RAJKAI, T. (1970): Általános iskolás gyermekek növekedésének szakaszossága hosszmetszeti vizsgálat alapján. - Anthrop. Közl. *26*, 13-34.

SZABÓ, T., PÁPAI, J. and SZMODIS, I. (1991): The effect of intense physical training on some somatic indices and body composition. Two case histories. In: SZMODIS, I., SZABÓ, T. and MÉSZÁROS, J. (eds): International Round-Table Conference on Sport Physiology. - MTE, Budapest, 213-226 pp.

SZÖLLŐSI, E. (1982): Growth and development of pupils in Debrecen, based on a mixed-longitudinal study from their age of 13 to 18 years. - Humanbiol. Budapest. *4*, 127-133.

SZÖLLŐSI, E. and JÓKAY, M. (1991): Developmental rate in Debrecen girls from the age of 7 to 22 years. - Anthrop. Közl. *33*, 97-103.

TANNER, J. M. (1962): Growth at Adolescence. 2nd ed. - Blackwell, Oxford.

TANNER, J. M., WHITEHOUSE, R. H., MARUBINI, E. and RESELE, L. F. (1976): The adolescent growth spurt of boys and girls of the Harpenden Growth Study. - Ann. Hum. Biol. *3*, 109-126.

VARGA, P., EIBEN, O. G., FARKAS, M. and VARGÁNÉ TEGHZE-GERBER, Zs. (1991): Percentiles of the human growth velocity, based on the "Budapest Longitudinal Growth Study". - Anthrop. Közl. *33*, 81-86.

WINTER, J. S. D. (1978): Prepubertal and pubertal endocrinology. In: FALKNER, F. and TANNER, J. M. (eds): Human Growth. Vol. 2: Postnatal growth. - Plenum Press, New York - London, 183-214 pp.

ACTA BIOL. SZEGED. 42, pp. 287-297 (1997)

FOCUS ON PHYSICAL AND SEXUAL MATURATION: THE CASE OF BELGIUM

C. SUSANNE[1] and M. VERCAUTEREN[2]

[1]*Laboratory of Anthropogenetics and Ecotechniques, Vrije University in Brussels, Pleinlaan 2, 1050 Brussels, Belgium*

[2]*Laboratoire d'Anthropologie et Génétique Humaine, Université Libre de Bruxelles, Av. Roosevelt 50; C.P. 192. 1050 Brussels, Belgium*

(Received: January 6, 1997)

Introduction

One of the earliest observations illustrating a secular trend was that pertaining to the increase in stature. However, since the 19th century, other modifications have been observed in almost all industrialized countries, such as an increase in weight and earlier physical and sexual maturation (VAN WIERINGEN, 1978; WOLANSKI, 1978; EVELETH and TANNER, 1990). The published data are very consistent: menarche is now taking place between 2 and 3.5 years earlier than a century ago. Thus, secular changes in body dimensions have occurred simultaneously with secular changes in tempo of growth, as shown during the last 100 years by ever earlier ages at menarche and at peak height velocity (about 3-4 months earlier per decade in most European countries; EVELETH and TANNER, 1990).

The trends observed for height and weight, especially at the time of puberty, agree with this observation of earlier maturation (TANNER, 1968). The higher tempo of growth has resulted in adult height being reached at an earlier age.

As individual growth is a barometer of a child's health, it is important to consider secular changes in growth and tempo of growth as indicators of a population's changing nutritional, hygienic and health status (SUSANNE, 1985; VAN WIERINGEN, 1986; TANNER, 1992); for example, in industrialized countries, the trend may slow down or be reversed during periods of hunger and war (BRUNDTLAND et al, 1980; LIESTOL and ROSENBERG, 1995), and in some developing countries no or only a very slight secular trend has been observed.

Many factors (familial, genetic or socio-economic) may influence growth and menarche (MARESH, 1972; EVELETH and TANNER, 1990). Improvements in environment and nutrition probably exert simultaneous influences (BAKWIN, 1964a; SHORTER, 1981).

Like most other European countries, Belgium has been characterized both by a movement towards earlier maturation and menarche, and by an increase in height at each age (DEFRISE, 1967; JEURISSEN, 1969; VERCAUTEREN, 1984; VERCAUTEREN and SUSANNE, 1986).

Material and methods

In 1980-82, 4177 Belgian subjects (2093 males and 2084 females) aged 3-26 years were measured once during medical examinations by the Brussels Central Health Service. These children, attending various educational establishments in Brussels, had very varied socio-economic backgrounds, representative of the diversity of social origins of the Belgian population living in Brussels (city and suburbs) (VERCAUTEREN, 1984).

From this sample, 1048 girls aged 9-17 years (with their birth years falling between 1963 and 1971) were asked about their menarcheal status. Data were collected with the status quo method, which is more accurate than the recall method (BRUNDTLAND and WALLOE, 1973). The girls were grouped in age classes of 6 months. Probits were used and the median age and standard error of the median were estimated.

To allow comparison of our results with those of JEURISSEN (1969), a method of centiles was also used.

Results

A. Secular trend in tempo of statural growth

During puberty, an acceleration of growth in terms of stature (or weight) has been observed universally (LJUNG et al., 1974; EVELETH and TANNER, 1990); it is detected through the well-known peak height (or weight) velocity.

A secular trend in the tempo of growth is observed through the advance of the adolescent spurt and explains why, temporarily during adolescence, the secular trend in size is greater than during childhood and adulthood. For instance, the average secular increase in height in Europe and North America between 1880 and 1980 was about 1.5 cm/decade during childhood, 2.5 cm/decade during adolescence and about 1 cm/decade in adulthood (EVELETH and TANNER, 1990).

Studies on secular trends in age at peak height velocity of a population are scarce, due to difficulties in estimating this biological parameter: age at peak height velocity determinations, derived from the increments in the cross-sectional mean heights, are in general inefficient. Indeed, if the cross-sectional data are grouped into the usual 1-year age classes, the maximum increment can be estimated only to the nearest year (HAUSPIE et al., 1996). Nevertheless, this procedure may sometimes underline a trend. In her comparison of the Belgian data from 1948 and 1960, DEFRISE (1967) found an earlier maximum growth rate (or peak) in the 1960 sample for girls and boys. However, when an identical methodology (graph of annual increases in stature) is used, no differences in the ages at this peak seems to exist between the 1960 and 1980 children.

Calculation of the fit of a growth model to the means has been used to obtain a better estimate of age at the maximum increment of height (TANNER et al., 1982; VERCAUTEREN, 1984, 1993).

Figure 1 shows the secular trend in age and peak height velocity in Belgian girls, the PREECE-BAINES model (1978) being applied to data from 1830 (QUETELET, 1831), 1930 (GALET, 1931), 1960 (TWIESSELMANN, 1969) and 1980-82 (VERCAUTEREN, 1984). After a very slow advance during last century - in fact, surveys on the stature of conscripts revealed that the process of secular trend began around 1920 in Belgium (CHAMLA, 1964) - the adolescent spurt advanced very quickly between 1930 and 1960. Subsequently, there has been a further slight trend towards earlier maturation in height, but of only 0.1 year between 1960 and 1980. This suggests a decrease in rate in the secular trend relating to the age of puberty.

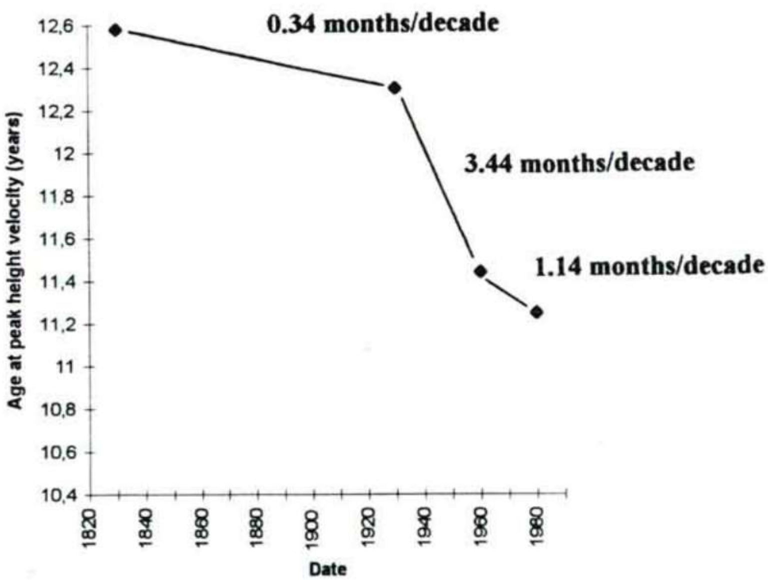

Fig. 1. Secular trend in age and peak height velocity in Belgian girls. Age and peak height velocity is estimated by applying the PREECE-BAINES model to data from 1830 (QUETELET, 1831), 1930 (GALET, 1931), 1960 (TWIESSELMANN, 1969) and 1980-82 (VERCAUTEREN, 1984).

B. Secular trend in menarcheal age

Secular changes in tempo of growth are best documented by data concerning the age at menarche.

The median age at menarche and its standard error, calculated by probit analysis on the Belgian 1980-82 survey is 13.06 ± 0.06 years, with a standard deviation of 1.47 year.

We may compare our results with the data from 1915 to 1959 collected by JEURISSEN (1969) in different welfare centres in Brabant (Belgium). Figure 2 represents the age at which 10%, 50% and 90% of the girls reached menarche; it clearly shows the tendency towards earlier sexual maturation (C50) between the 1920 and 1960s. During this period, the mean age at menarche in Belgian girls advanced by 4.5 months/decade. The obvious shift of age at peak height velocity observed during the same period should be borne in mind.

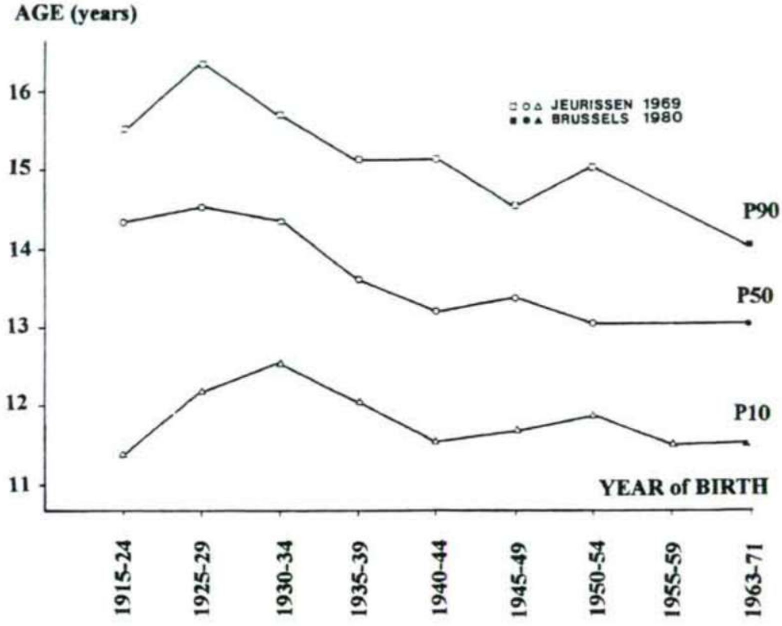

Fig. 2. Secular trend, according to year of birth, in menarcheal age and its distribution (C10, C50, C90) in Belgium.

If the 10th centile for age at menarche has remained almost unchanged at around 11.8 years, the 90th centile has decreased by about 4.8 months/decade.

The centile method applied to the recent sample gives a median age of 13.0 years, which is unchanged in comparison with the girls born between 1950 and 1954. Hence, for the first time in Belgium, it seems that the median age has stabilized. However, C90 is attained at a lower age: 14.0 instead of 15 years. Hence, the secular trend in age at menarche in the most recent period was merely a result of a decreased number of girls who mature late. This continues to cause a considerable reduction in the variability of the process of reaching menarche, as seen in Fig. 3, where we have applied probit curves to our sample and to two of those of JEURISSEN: the "sitting upright" is very clear through the surveys. These results suggest that medical progress and better socio-economic conditions during recent decades have eliminated most of the factors causing late menarche (VERCAUTEREN and SUSANNE, 1985).

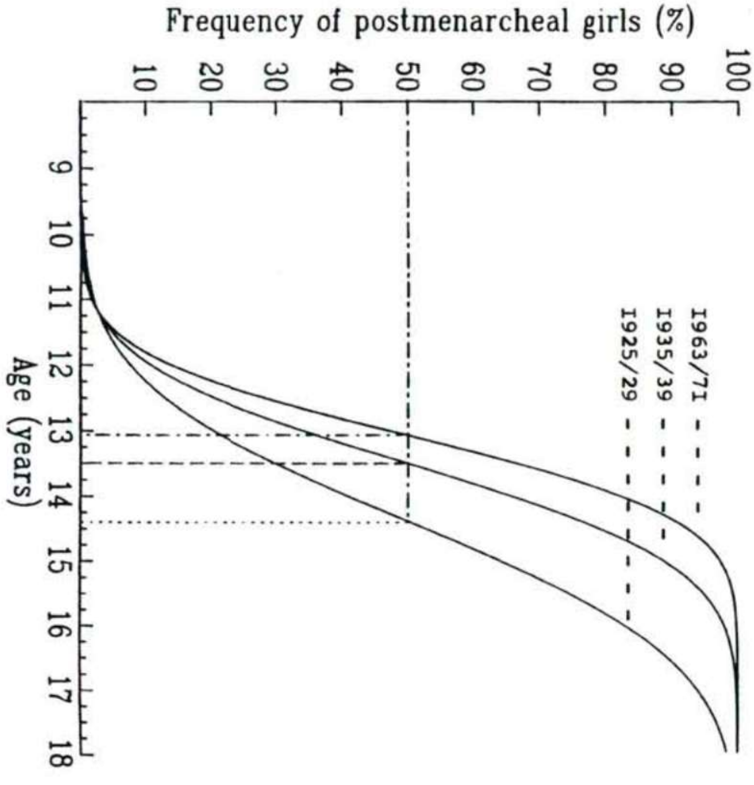

Fig. 3. Secular trend in menarcheal age in Belgium. Probit curves are calculated from surveys of JEURISSEN (1969) and VERCAUTEREN (1986).

C. Menarcheal age and some socio-familial factors

To explain the variation in the age at menarche, the socio-economic level is often taken into account, girls of lower social origin on the average exhibiting a delay in first menstruation as compared with girls from well-off families (BIELICKI et al., 1982; EVELETH et al., 1990). Therefore, we studied this social influence in our sample, where we discriminated two sub-groups on the basis of the level of education of the parents:

- high level: university or high school studies;

- low level: primary or low secondary schools (this means schooling up to 12 to 15 years of age).

The mean ages and the results of the t-tests in Table 1 indicate no significant differences due to social background in our sample from Brussels, at least for the data relating to the age at menarche.

The size of the family is also considered to have an impact on the menarcheal status: young girls from small families reach menarche more precociously (MARESH, 1972). Again we distinguished two groups:

- Small families: families with only one daughter or with 2 children at most;
- Large families: 3 children or more.

Table 2 clearly shows that for daughters in large families there is a small (but significant) delay of maturation (Fig. 4).

Table 1. Comparison of menarcheal age (mean and standard error) and social status (educational level) of the parents; data on girls from Brussels.

	years	N	t-test	significance
Educational level of father				
low level	13.04 ± 0.13	344		
high level	13.11 ± 0.11	285	0.58	N.S.
Educational level of mother				
low level	13.03 ± 0.11	399		
high level	13.19 ± 0.14	213	1.33	N.S.

Table 2. Comparison of menarcheal age (mean and standard error) and family size; data on girls from Brussels.

	years	N	t-test	significance
Family size				
Small families	13.00 ± 0.08	711		
Large families	13.26 ± 0.11	382	32.5	p< 0.001

We also examined the level of education of the girls from the Brussels schools, distinguishing two groups:

- girls with normal school progress (or one year in advance of their age);
- girls displaying a delay of at least one year in their schooling.

A slight (but significant) delay of first menstruation is observed among backward pupils (Table 3 and Fig. 5).

Table 3. Comparison of menarcheal age (mean and standard error) and schooling level of girls.

	years	N	t-test	significance
Schooling level of child				
Normal	12.98 ± 0.08	791		
Delayed	13.42 ± 0.13	293	4.89	p< 0.001

Discussion

The two factors most often cited to explain the secular trend are the better living standards (hygiene, medical care, etc.) and better nutrition. It would be difficult to dissociate these two factors, however, as changes in one usually have repercussions on the other. Therefore, environmental changes and nutrition very probably act simultaneously (TANNER, 1968).

In the same way, an abnormal situation has been observed in the case of Belgian girls born between 1930 and 1934, who were influenced by the poor environmental (and alimentary) conditions of the Second World War: amongst these girls, there were few cases of early menarche and many late menarches (JEURISSEN, 1969, and Fig. 2). At the same time, during (or just after) the war, a diminution in stature was noted in some populations, including that in Belgium (ELLIS, 1945; CHAMLA, 1964). Similar observations led some authors to hypotheze that a positive secular trend would result from the disappearance of factors delaying growth and development (VAN WIERINGEN, 1978).

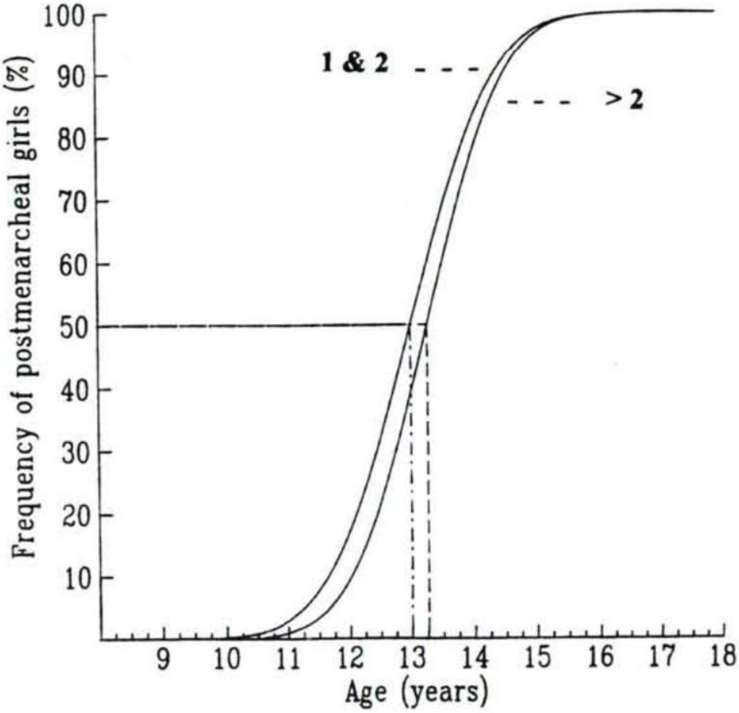

Fig. 4. Menarcheal age according to the size of the family. Probit curves. Brussels, 1980-1982.

More recent publications concerning the age at menarche in the Belgian population are not frequent. A large sample has recently been studied in Belgium (BECKERS and PLEYSIER, 1982): the status quo method gives 12 years 10 months as the median for the girls from the French-speaking part of the country; however this population includes 17% of foreign children and a direct comparison with our sample is therefore difficult. The median age for the Flemish-speaking part of the country (which includes only 2% of foreign children) is 13 years 1 month.

Our results seem to indicate that, as far as Belgium is concerned, the secular trend of the age at menarche has come to a halt at 13.0 years. This is perhaps the first time that the end of this secular trend has been observed in Belgium, but it is not the first time in Europe (HAUSPIE et al., 1996). If the trend is still continuing in The

Netherlands, Sweden, Spain, Germany (Bremerhaven) and Eastern Europe (The Czech Republic and Hungary (Szeged), FARKAS, 1983), a very small decrease in the age at menarche has also been observed in London (TANNER, 1973). The end of the secular trend at around 13.2 years has been observed in Norway (BRUNDTLAND and WALLOE, 1973; LIESTOL and ROSENBERG, 1995). In Massachusetts (DAMON, 1974), a stabilization of the age at menarche at 13.1 years has likewise been observed. The similarity between the ages in Belgium, Norway and Massachusetts should be noted.

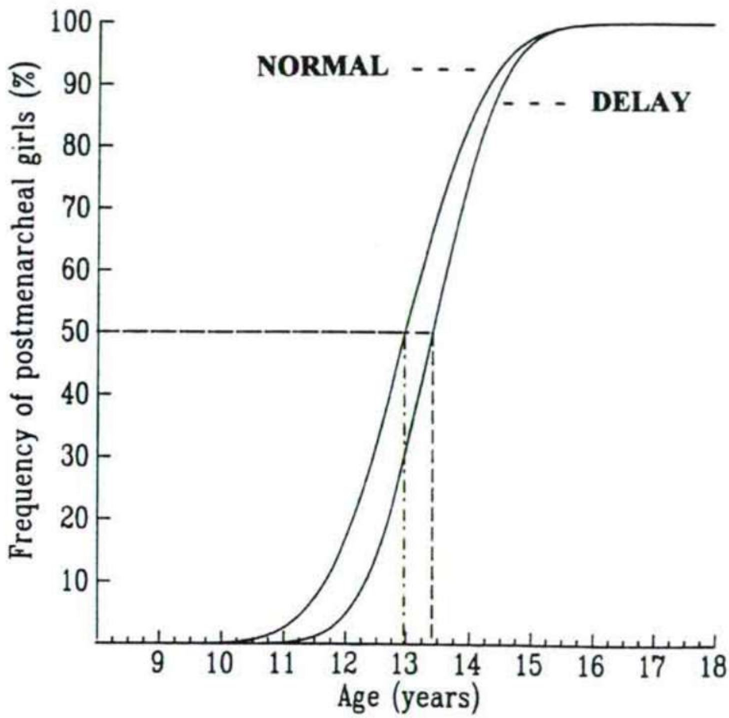

Fig. 5. Menarcheal age according to the schooling level of girls. Probit curves. Brussels, 1980-1982.

Thus, it appears that, although the age at menarche was still advancing in many countries in the 1970s and 1980s, it has stopped or even reversed in others (Sweden (Stockholm), Hungary (Körmend), Croatia (Zagreb) (HAUSPIE et al., 1996).

It may be interesting to make a parallel with statural changes during the recent period for Belgium. Between 1960 and 1980-82, if there was still a significant increase in stature at almost all ages for boys and girls, secular changes during adolescence were of almost the same magnitude as those during childhood or adulthood. This strongly suggests that the secular increase in height that occurred between 1960 and 1980-82 was due solely to an upward shift in stature at all ages and not to a secular change in tempo of growth (HAUSPIE et al., 1996). Of course, this is supported by the facts that the age at peak height velocity has undergone almost no change, and that the age at menarche in Belgian girls has stabilized at the age of 13 years during this period.

With the disappearance of the C50 secular trend, it was possible to postulate the disappearance of socio-economic differences in Belgium as far as menarche is concerned, as has already been observed in Sweden (LINDGREN, 1976). This seems to be the case, as shown here.

However, a relationship between the age at menarche and the dimensions of the family and/or level of education still exists. Here too, we can compare it with similar trends in stature: many studies have indeed shown the influence of the familial dimensions on stature, children of small families being on the average taller (RONA, 1981; EVELETH and TANNER, 1990).

We observed this too in our Brussels population (SUSANNE and VERCAUTEREN, 1996, for the dimensions of the family; and FREESE et al., 1986, for the educational level).

If no secular trend has been observed in the median age at menarche, we have seen that the variability in the process of maturation is still regularly diminishing in the Belgian population: the 90th centile for the age at menarche has decreased by about 2 years during recent decades, while the 10th centile has remained virtually unchanged over the same period.

Again a comparison with stature is of interest. The mean stature continues to increase in most of the industrialized countries, but the difference between the socio-economic groups is decreasing (LINDGREN, 1983). A cessation of the secular trend of stature has been observed only for children in higher social groups (BAKWIN, 1964b; DAMON, 1968; KIMURA, 1977).

A similar trend has been detected in Belgium: from a comparison of the mean heights of Belgian university students and conscripts, SUSANNE and HEYNE (1972) suggested a kind of catch-up phenomenon. Later, other results clearly showed that the different social classes did not follow the same secular trend: girls from the more favoured group revealed no secular trend during 20 years, while in the less favoured group a significant positive rate of 1.8 cm/decade was noted. This results in a clear decrease in the deviations, and hence in the variability (SUSANNE and VERCAUTEREN, 1996). The relationship between stature and number of children per family revealed the same reduction in growth difference between the samples of 1960 and 1980-82.

In conclusion, if observations in some countries do seem to reveal a clear decrease or even an end of the global positive secular trend, there is still a trend towards a reduction in the variability of growth and maturation measurements in these populations.

References

BAKWIN, H. (1964a): The secular change in growth and development. - Acta Paediatr Scand. *53*, 79-89.
BAKWIN, H. (1964b): Secular increase in height: is the end in sight. - Lancet *2*, 1195-1196.

BECKERS, R. and PLEYSIER R. (1982): Antropometrische analyse van de Belgische schoolbevolking 1980-1981. deel 2: Eerste resultaten. - Ministerie van Volksgezondheid en van het Gezin. Brussel, 82 p.

BIELICKI, T. and WELON, Z. (1982): Growth data as indicators of social inequalities: the case of Poland. - Yearbook of Physical Anthropology *25*, 153-167.

BRUNDTLAND, G. H. and WALLOE, H. (1973): Menarcheal age in Norway: halt in the trend towards earlier maturation. - Nature *241*, 478-479.

BRUNDTLAND, G. H., LIESTOL, K. and WALLOE, L. (1980): Height, weight and menarcheal age of Oslo schoolchildren during the last 60 years. - Ann.. Hum. Biol. *7*, 307-322.

CHAMLA, M. C. (1964): L'accroissement de la stature en France 1880-1960; comparaison avec les pays occidentaux. - Bulletin et Mémoires de la Société d'Anthropologie de Paris *6*, 201-278.

DAMON, A. (1968): Secular trend in height and weight within old American families at Harvard, 1870-1965; I: within twelve-four generation families. - Am. J. Phys. Anthropol. *29*, 45-50.

DAMON, A. (1974): Larger body size and earlier menarche: the end may be in sight. - Soc. Biol. *21*, 8-11.

DEFRISE-GUSSENHOVEN, E. (1967): Evolution de la croissance des écoliers bruxellois de 1948 à 1960. - Bulletin de la Société royale belge d'Anthropologie et de Préhistoire *78*, 41-70.

ELLIS, R. (1945): Growth and health of Belgian children during and after the German occupation, 1940-44. - Arch. Dis. Child. *20*, 97-109.

EVELETH, P. B. and TANNER, J. M. (1990): Wordwide Variation in Human Growth; ed. 2. - Cambridge University Press, Cambridge, 397 p.

FARKAS, Gy. (1983): Über die körperliche Entwicklung von Kindern im Vorsschulalter. Untersuchungen in Szeged (Südungarn). - Anthropol. Anz. *41*, 53-58.

FREESE, V., VERCAUTEREN, M. and LEPAGE, Y. (1986): Croissance, état d'avancement scolaire et milieu socio-familial. - Bulletin de la Société royale belge d'Anthropologie et de Préhistoire *97*, 133-145.

GALET, O. (1931): Essai de détermination de quelques moyennes staturales et pondérales correspondant à diverses étapes de développement infantile; Analyse sommaire de l'influence de certains facteurs sociaux sur l'évolution de la croissance. - Bulletin de la Société d'Anthropologie de Bruxelles *46*, 138-316.

HAUSPIE, R.C., VERCAUTEREN, M. and SUSANNE C. (1996): Secular changes in Growth. - Horm. Res. *45*, 8-17.

JEURISSEN, A. (1969): L'âge au moment des premières règles et son évolution au cours des quarante dernières années. - Acta Paed. Belg. *23*, 319-330.

KIMURA, K. (1977): Has the secular trend for greater height ceased in Japanese? - J. National Defense Medical College *2*, 72-76.

LIESTOL, K and ROSENBERG, M. (1995): Height, weight and menarcheal age of schoolgirls in Oslo - an update. - Ann. Hum. Biol. *22*, 199-205.

LINDGREN, G. (1976): Height, weight and menarche in Swedish urban school children in relation to socio-economic and regional factors. - Ann. Hum. Biol. *3*(6), 501-528.

LINDGREN, G. (1983): Croissance d'enfants de villes suédoises en relation avec leur statut socio-économique. - Bulletin de la Société royale belge d'Anthropologie et de Préhistoire *94*, 193-206.

LJUNG, B. O., BERGSTEN-BRUCEFORS, A. and LINDGREN, G. (1974): The secular trend in physical growth in Sweden. - Ann. Hum. Biol. *1*, 245-256.

MARESH, M. (1972): A 45 year investigation for secular changes in physical maturation. - Am. J. Phys. Anthropol. *36*, 103-110.

PREECE, M. A. and BAINES, M. J. (1978): A new family of mathematical models describing the human growth curve. - Ann. Hum. Biol. *5*, 1-24.

QUETELET, A. (1831): Recherches sur les lois de la croissance de l'homme. - Mémoires de l'Académie de Bruxelles *7*, 1-27.

RONA, R. J. (1981): Genetic and environmental factors in the control of growth in childhood. - British Medical Bulletin *37*(3), 265-272.

SHORTER, E. (1981): L'âge des premières règles en France, 1750-1950. - Annales E.S.C. *36*(3), 495-511.

SUSANNE, C. (1985): Living conditions and secular trend. - J. Human Evol. *14*, 357-370.

SUSANNE, C. and HEYNE, D. (1972): Stature, poids et capacité vitale des étudiants et étudiantes de l'Université Libre de Bruxelles. - Bulletin de la Société royale belge d'Anthropologie et de Préhistoire *83*, 101-105.

SUSANNE, C. and VERCAUTEREN, M. (1996): Growth: a health indicator and social barometer. The case of Belgium. In: BODZSAR, B. E. and SUSANNE, C. (eds): Studies in Human Biology. - Eötvös University Press, Budapest, 113-129 pp.

TANNER, J. M. (1968): Earlier maturation in man. - Scientific American *218*, 21-27.

TANNER, J. M. (1973): Trends towards earlier menarche in London, Oslo, Copenhagen, The Netherlands and Hungary. - Nature *243*, 95-96.

TANNER, J. M. (1992): Growth as a measure of the nutritional and hygienic status of a population. - Horm. Res. *38*, 106-115.

TANNER, J. M., HAYASHI, T., PREECE, M. A. and CAMERON, N. (1982): Increase in length of leg relative to trunk in Japanese children and adults from 1957 to 1977: comparison with British and with Japanese Americans. - Ann. Hum. Biol. *9*, 411-423.

TWIESSELMANN, F. (1969): Développement biométrique de l'enfant à l'adulte. - Presses Universitaires de Bruxelles, Bruxelles, 147 p.

VAN WIERINGEN, J. C. (1978): Secular growth changes. In: FALKNER, F. and TANNER, J. M. (eds): Human growth, vol. 2. - Plenum Press, New York, 445-473 pp.

VAN WIERINGEN, J. C. (1986): Secular growth changes. In: FALKNER, F. and TANNER, J. M. (eds): Human growth, vol. 3. - Plenum Press, New York, 307-331 pp.

VERCAUTEREN, M. (1984): Evolution séculaire et normes de croissance chez des enfants belges. - Bulletin de la Société royale belge d'Anthropologie et de Préhistoire *95*, 109-123.

VERCAUTEREN, M. (1993): Croissance, facteurs socio-familiaux et évolution séculaire. - Bulletin et Mémoires de la Société d'Anthropologie de Paris *5*, 85-92.

VERCAUTEREN, M. and SUSANNE, C. (1985): The secular trend of height and menarche in Belgium: are there any signs of a future stop? - Eur. J. Pediatr. *144*, 306-309.

VERCAUTEREN, M. and SUSANNE, C. (1986): Observations sur l'âge de la ménarche en Belgique. - Bulletin et Mémoires de la Société d'Anthropologie de Paris *3*, 205-220.

WACCHOLDER, A. and CANTRAINE F. (1974): Etude de la puberté. Parametres somatiques (taille-poids) et sociaux des 56 filles de l'échantillon belge. - Centre International de l'Enfance, Compte-rendu, 64-76 pp.

WOLANSKI, N. (1978): Secular trend in man: Evidence and Factors. - Collegium Anthropologicum *2*(1), 69-86.

ACTA BIOL. SZEGED. 42, pp. 299-305 (1997)

DATA ON THE BIOLOGICAL DEVELOPMENT OF GIRLS IN SOMOGY COUNTY (PRELIMINARY STUDY)

CS. SUSKOVICS

Department of Biological Anthropology, Eötvös Loránd University, H-1088 Budapest, Puskin u. 3. Hungary

(Received: December 18, 1996)

Abstract

The biological status of 15 per cent (1201) of the 10-14-year-old girls in Somogy County was investgated in 1995-96. The height, weight and age at menarche were studied by the status quo method and probit analysis. The median age at menarche was 12.63 years. The results indicate a positive secular trend in the somatic development of girls in Somogy County during the past 50 years.

Key words: Somogy County girls, age at menarche, height, weight.

Introduction

The age at the appearance of the menarche is one of the most important attributes in the biological development of girls. It mostly appears after the adolescent growth spurt, at the end of puberty.

In recent decades, a number of Hungarian researchers have studied the age at menarche and the genetic and environmental factors influencing it (BODZSÁR, 1975; BOTTYÁN et al., 1963; EIBEN and PANTÓ, 1985; EIBEN, 1988; FARKAS, 1990, EIBEN et al., 1991). A correlation has been thought between the menarche and the body composition (PANTÓ, 1980; PÁPAI and BODZSÁR, 1990; BODZSÁR, 1991), and the interrelationship between the age at menarche and physical performance has been studied (PÁPAI et al., 1992). The publications reveal that the age at menarche is determined by genetic endowments and environmental factors. It is clear that the age at menarche is appearing earlier and earlier; the onset of puberty occurs much sooner than 50-100 years ago.

Investigations have been carried out on the growth and maturation of children living in Somogy County (Southern Hungary) since the early part of this century. The first was performed among kindergarten and primary school children between 1928 and 1931 by a paediatrician GYÖRGY VÉLI (1936). He wrote several papers on the growth and maturation of Kaposvár children (VÉLI, 1967, 1968). He proposed that, instead of acceleration, it would be better to speak about the elimination of the earlier retardation. BODZSÁR and VÉLI (1980) published data on the physical development of young people in Kaposvár. KÖRNYEI et al. (1980, 1983) investigated 1806 Kaposvár children and published their body measurements and the age at menarche in girls (1983). GELENCSÉR et al. (1986) analysed the changes in height, weight and age at menarche in the past 50 years from the aspects of a secular trend. VÁSÁRHEGYI (1985) presented data on the age at menarche in Nagyatád. At the beginning of the 1980s, within the scope of the Hungarian National Growth Study, a representative growth survey (organized and directed by Prof. O. G. EIBEN), a sample of 974 boys and girls was investigated in Somogy County (EIBEN et al., 1990).

The results of these studies demonstrate a positive secular trend in the growth of children and in the age at menarche in the past 50 years. Some authors have pointed out a relatively new phenomenon: the positive secular trend of the menarcheal age stopped for a short time, and subsequently later menarche medians were reported than before from the same place (ROBERTS and DANN, 1967, 1975; KÁDÁR and VÉLI, 1977; RONA, 1981; EIBEN, 1988).

The question arose of whether this secular trend in the age at menarche still exists in girls in Somogy County in recent decades. Since the study is still in progress, some preliminary data are presented in this paper.

Material and methods

The area of this study is Somogy County, which is situated in the south-western part of Hungary, south of Lake Balaton. The study was carried out in the school year 1995-96. In the selection of the localities, the author considered the previous places of research in Somogy County, the number of inhabitants and/or the size of the settlements, and the distribution of children according to age between 10 and 14 years by settlements. It was planned to involve 20% of the 10-14-year-old Somogy County children in the investigation. Height, weight and menarche data on 1201 girls were measured in the county-town Kaposvár and in other towns and villages in Somogy County. The anthropometric programme involved 18 body measurements according to the MARTIN technique (MARTIN and SALLER, 1957), with regard to the recommendations of the International Biological Programme (TANNER et al., 1969). Data on menarcheal age were collected by the status quo method, and the median was calculated by means of probit analysis.

Result and discussion

Table 1 compares the mean height and weight data between the foregoing studies in Kaposvár and Somogy County and the results which were measured by myself among Somogy County girls. These parameters have continued to increase. The changes are particularly marked at the ages of 10-11. The 10-year-old was on average 6 cm taller in 1996 than in the eighties, and 13 cm taller than in 1947. This indicates the earlier appearance of the puberty growth impulse. Among 12-14-year-olds, there is not such a significant change, but there is still an increasing tendency. It is clear there is a positive seculary trend that in the development of both height and weight.

Table 2 shows the distribution of pre- and postmenarcheal girls. It can be seen that the 10-11-year-olds include postmenarcheal girls although in small number. As compared with the data from 1947 and 1962 (VÉLI, 1968), the changes are noteworthy: VÉLI did not find any girls in this age group who had menstruated.

Table 1. Mean heights and weights of 10-14-year-old Kaposvár and Somogy County girls.

Year of the investigation and author		Height (cm) 10	11	12	13	14	Weight (kg) 10	11	12	13	14
1947	*N*	172	169	161	175	147	172	169	161	175	147
VÉLI (1968)	*Mean*	132.2	137.3	143	147.8	154.7	28.4	32	35.5	40	47.2
1962	*N*	16	92	259	360	282	16	92	259	360	282
VÉLI (1968)	*Mean*	140.1	142.0	148.1	153.6	157.0	32.6	34.8	39.7	44.7	48.6
1975	*N*	283	300	257	278	292	283	300	257	278	292
BODZSÁR and VÉLI	*Mean*	137.7	143.8	149.8	156.3	159.8	31.1	35.9	39.9	46.4	49.7
(1980)	*SD*	6.3	7.3	7.1	6.5	4.7	6.1	7.9	7.8	8.4	8.8
1978	*N*	128	100	115	139	101	128	100	115	139	101
KÖRNYEI et al.	*Mean*	138.0	144.3	151.4	156.1	159.5	32.6	34.7	40.5	46.0	48.4
(1980)	*SD*	7.4	6.7	7.7	6.1	4.9	7.0	6.5	7.7	8.3	6.2
1981	*N*	134	124	104	114	100	134	124	104	114	100
KÖRNYEI et al.	*Mean*	138.0	144.5	151.6	156.4	160.0	32.7	35.9	43.3	47.3	51.0
(1983)	*SD*	7.5	7.3	7.1	7.1	6.0	7.8	6.6	9.9	9.7	6.7
1982	*N*	30	28	34	33	35	30	28	34	33	35
EIBEN et al.	*Mean*	139.4	144.7	150.2	155.2	157.6	32.3	37.0	42.4	46.3	49.8
(1990)	*SD*	7.6	6.9	7.1	6.6	5.1	8.0	9.0	11.5	8.5	6.6
1996	*N*	91	243	297	343	194	91	243	297	343	194
SUSKOVICS	*Mean*	145.4	146.3	152.1	156.7	160.3	37.7	39.2	44.0	48.3	52.7
	SD	7.4	7.0	7.7	6.6	7.3	7.5	9.9	10.6	10.6	9.8

Table 2. Distribution of the premenarcheal and postmenarcheal girls in Somogy County.

Age (years)	N	Postmenarcheal N_1	%	Premenarcheal N_2	%
10,0	4	1	25.00	3	75.00
10,5	87	4	4.60	83	95.40
11,0	112	8	7.14	104	92.86
11,5	131	13	9.92	118	90.08
12,0	161	41	25.47	120	74.53
12,5	136	61	44.85	75	55.15
13,0	150	93	62.00	57	38.00
13,5	193	159	82.38	34	17.62
14,0	138	127	92.03	11	7.97
14,5	56	52	92.86	4	7.14
15,0	16	14	87.50	2	12.50
15,5	8	7	87.50	1	12.50
16,0	9	9	88.89	0	0.00

Table 3 presents the mean heights and weights of the pre- and postmenarcheal girls, from Figs 1 and 2. The data clearly reveal that the postmenarcheal girls are much taller and heavier than their postmenarcheal contemporaries. There is a positive relation between the body development and the menarche. According to "critical body weight" theory of FRISCH and REVELLE (1969), the attainment of a certain weight may be critical from the point of view of menarche. This specific weight leads to changes in the metabolism. If there is a role of the weight at the growth speed peak in the appearance of the menarche, the earlier secular trend is explainable. FRISCH and REVELLE (1969) claims that a critical weight cause the menarche: 47-48 kg. The present research results indicate that the postmenarcheal girls have a mean weight of 42.33-60.14 kg, compared with 35.90-46.60 kg for the premenarcheal girls. Comparison of the age at menarche m=12.63 years with its nearest age average 50.25 kg body weight indicates that on average girls aged 12.5 years have reached FRISCH and REVELLE "critical body weight". This theory of "critical body weight" is valid in the Somogy County sample. The results confirmed that the menarche appears in the year following the largest growth of the body, the puberty growth impulse peak (VÉLI, 1968).

Table 3. Height and weight of premenarcheal and postmenaercheal girls in Somogy County.

	Height (cm)				Weight (cm)			
Age (year)	Premenarcheal		Postmenarcheal		Premenarcheal		Postmenarcheal	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
10	146.93	3.86	162.30	0.00	40.00	5.00	47.00	0.00
10.5	143.53	5.87	152.73	8.31	35.90	6.76	42.33	4.93
11	146.04	6.09	155.43	6.50	38.27	9.50	60.14	9.89
11.5	148.34	8.00	156.70	7.84	39.93	9.42	52.58	10.91
12	150.20	6.99	155.13	6.04	40.66	8.69	52.15	8.63
12.5	152.50	8.32	157.04	6.02	42.78	9.28	50.25	9.66
13	154.33	6.23	157.53	5.28	43.18	8.84	51.73	11.63
13.5	158.23	5.89	159.64	7.10	45.96	9.82	52.66	9.32
14	161.08	11.60	160.57	6.73	46.60	9.52	52.70	9.63
14.5	161.53	2.98	160.02	8.59	45.75	2.06	51.67	9.29

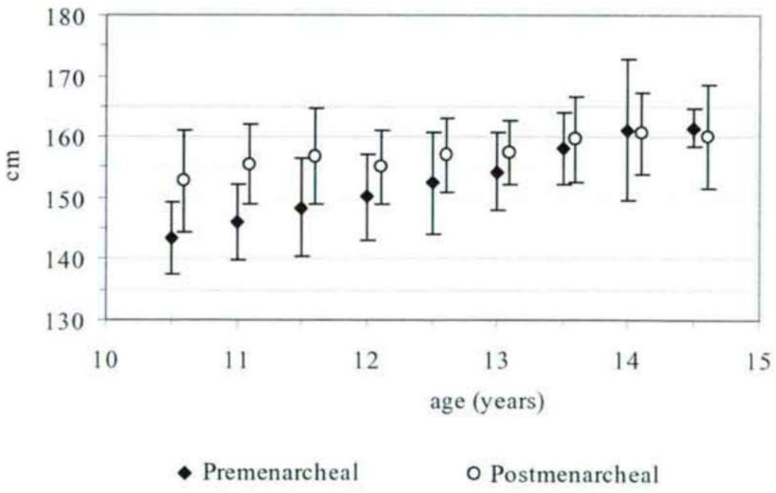

Fig. 1. Height of the premenarcheal and postmenarcheal County Somogy girls.

Table 4 detailes the Somogy County median data of relating to the age at menarche. VÉLI reported that the age at menarche was in 1947 in Kaposvár m=13.9 years. There has subsequently been a downward tendency. The age at menarche has been approximately constatnt during the past 15 years, though the Hungarian National Growth Study found a minimum of m=12.55 years in Somogy County in 1982, which was the lowest age from any county (EIBEN et al., 1990). In comparison with this a slightly higher age at menarche has been found in 1996. Taking everything into consideration, it seems that the positive secular trend in the development of the age at menarche is currently not very marked. At the beginning of the eighties, the samples collected from all over Hungary gave the age at menarche for the whole of the country as m=12.79 year (EIBEN et al., 1990). The menarche median for girls living in Somogy County (m=12.63) is earlier than that. BODZSÁR (1975) found m=12.61 years in Székesfehérvár in 1971, CSÓKA et al. (1981) m=12.58 years in Csepel in 1970-80, BODZSÁR (1983) m=12.61 in Veszprém in 1978, EIBEN et al. (1991) m=12.4 years in Budapest during the longitudinal growth research between 1970 and 1988.

Table 4. Somogy County data relating to the age at menarche.

Site of sampling	Time of sampling	Age at menarche (year)	Author and year of publication
Kaposvár	1947	13.90	VÉLI 1968
Kaposvár	1962	12.98	VÉLI 1968
Kaposvár	1981	12.69	KÖRNYEI et al. 1983
Somogy County	1982	12.55	EIBEN et al. 1990
Nagyatád	1982	12.63	VÁRHEGYI 1985
Somogy County	1996	12.63	SUSKOVICS (present study)

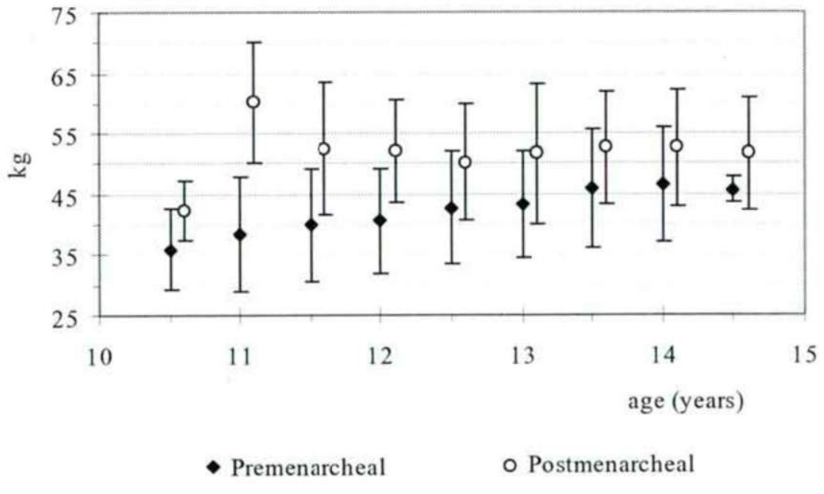

Fig. 2. Weight of the premenarcheal and postmenarcheal County Somogy girls.

Summary

The biological status of 15 per cent (1201) of the 10-14-year-old girls in Somogy County was investigated in 1995-96. The study extended to the height, weight and the age at menarche by the status quo method and probit analysis. The median age at menarche was m=12.63 years. It can be stated that there has been a positive secular trend in the past 50 years in the somatic development of girls in Somogy County.

Acknowledgements

The author is greatful to Professor OTTÓ EIBEN for professional direction and valuable advice in the planning of the research and the treatment of the material, to Dr JÓZSEF BUDAY for help with the probit analysis, and to the directors of schools in Somogy County for the possibility to carry out this research.

References

BODZSÁR, É. (1975): A testi fejlettség és a menarche a székesfehérvári leányoknál. - Anthrop. Közl. *19*, 78-85.

BODZSÁR, É. (1983): A pubertáskor érési folyamatai bakonyi leányoknál. - Anthrop. Közl. *27*, 29.

BODZSÁR, É. (1991): The Bakony Growth Study. - Humanbiol. Budapest. *22*.

BODZSÁR, É. and VÉLI, Gy. (1980): The changing of height and weight of body during half a century in Hungary. - Glass. Antr. Dr. Jug. *17*, 69-75.

BOTTYÁN, O., DEZSŐ, GY., EIBEN, O., FARKAS, GY., RAJKAI, T., THOMA, A. and VÉLI, Gy. (1963): A menarche kora Magyarországon. - Anthrop. Közl. *7*, 25-39.

CSOKA, M., PHILIPPNÉ JUNG, R. and EIBEN, O. G. (1981): Csepeli lányok testi fejlettsége, érése és szomatotípusa. - Nemzetközi Centenáris Antropológiai Kongresszus Előadáskivonatai. Budapest, 1989.

EIBEN, O. (1988): Szekuláris növekedésváltozások Magyarországon. - Humanbiol. Budapest. Suppl. *6*.

EIBEN, O., BARABÁS, A. and PANTÓ, E. (1991): The Hungarian National Growth Study I. Reference data on the biological developmental status and physical fitness of 3-18-year-old Hungarian youth in the 1980s. - Humanbiol. Budapest. *21*.

EIBEN, O. G., FARKAS, M. KÖRMENDY, I., PAKSY, A., VARGA TEGHZE-GERBER, Zs. and VARGHA, P. (1992): A budapesti longitudinális növekedésvizsgálat 1970-1988. - Humanbiol. Budapest. *23*.

EIBEN, O., and PANTÓ, E. (1985): Adatok a magyar ifjúság biológiai fejlődéséhez a társadalmi tényezők függvényében. - Anthrop. Közl. *29*, 45-72.

EIBEN, O., PANTÓ, E., BARABÁS, A. and BÁNHIDI, M. (1990): Adatok Somogy megye ifjúságának biológiai fejlettségéhez és fizikai erőnlétéhez. - Humanbiol. Budapest. Suppl. *9*.

FARKAS, Gy. (1986): Relationships between the different factors and the age at menarche in Hungary. - Anthrop. Közl. *30*, 117-123.

FARKAS, Gy. (1990): Serdülés és környezet. - JATE, Szeged.

FRISCH, R. E. and REVELLE, R. (1969): The height and weight of adolescent boys and girls at the time of peak velocity of growth in height and weight: Longitudinal data.- Human Biology. *41*, 536-559.

GELENCSÉR, E., KÖRNYEI, V. and GYÓDI, G. (1986): Secular change of height, weight and age at menarche in Kaposvár children and youths during the past 50 years.- Anthrop. Közl. *30*, 151-154.

KÁDÁR, P. and VÉLI, Gy. (1977): A szekuláris trend 100 éve Somogy megyében. - Anthrop. Közl. *21*, 93-100.

KÖRNYEI, V., GYÓDI, GY., FARKAS, J. and GÁL, K. (1980): Normális és magas vérnyomás gyermekkorban, vérnyomásstandardok. - Orv. Hetil. *121*, 755-761.

KÖRNYEI, V., GYÓDI, GY., GELENCSÉR, E., KERCSÓK, K. and SZOKOLA, Á. (1983): Kaposvári leányok menarche kora 1981-ben. - Anthrop. Közl. *27*, 39-44.

MARTIN, R. and SALLER, K. (1957): Lehrbuch der Antropologie I. (3. ed.). - G. Fisher Verlag, Stuttgart.

PANTÓ, E. (1980): Age at menarche and body development in girls based on a cross-sectional study in Eger (Northern-Hungary). - Coll. Antropol. *4*, 163-173.

PÁPAI, J. and BODZSÁR, É. (1990): Menarcheal age and growth in Jászberény girls.- Anthrop. Közl. *32*, 151-158.

PÁPAI, J., SZMODIS, I. and BODZSÁR, É. (1992): Growth, maturation and performance.- Anthrop. Közl. *34*, 75-82.

ROBERTS, D. F. and DANN, T. C. (1967): Influences on menarcheal age in girls in a Welsh college. - Brit. J. prev. soc. Med. *21*, 170-176.

ROBERTS, D. F. and DANN, T. C. (1975): A 12-years study on menarcheal age.- Brit. J. prev. soc. Med. *29*, 31-39.

RONA, R. (1981): Genetic and environmental factors in the control of growth in child hood.- Brit. med. Bull. *37*, 265-272.

TANNER, J. M., HIERNAUX, J. and JARMAN, S. (1969): Growth and physique studies - In: WEINE, J. S. and LOURIE, J. A. (eds): Human Biology. A Guide to Field Methods. - IBP Handbook No. 9. Blackwell Sci. Publ. Oxford-Edinburgh, 76 pp.

THOMA, A. (1960): Age at menarche, acceleration and heritability. - Acta Biol. Acad. Sci. Hung. *11*, 241-254.

VÁRHEGYI, B. (1985): Body measuremnts and maturation of Nagyatád school children (in Hungarian). JATE TTK, Szeged, (diplomawork).

VÉLI, Gy. (1936): A kaposvári óvodás és elemi iskolás gyermekek testméretei. - Iskola és egészség *3*, 112-124.

VÉLI, Gy. (1967): Az akceleráció a felszabadulás előtt és után. - Anthrop. Közl. *11*, 25-30.

VÉLI, Gy. (1968): A testi fejlődés és a menarche. - Anthrop. Közl. *12*, 161-171.

ACTA BIOL. SZEGED. 42, pp. 307-314 (1997)

PHYSICAL DEVELOPMENT AND OBESITY IN CHILDREN IN THE BÓDVA VALLEY

GY. SZABÓ and M. PAP

Department of Human Biology, L. Kossuth University, Debrecen H-4010, P.O.B. 6., Hungary

(Received: December 10. 1996)

Abstract

The study reports some features of the physical development and the frequency of obesity among children in the Bódva valley (in Borsod-Abaúj-Zemplén County, North Hungary). The investigations involved 340 children, aged 7-15 yr of Gypsy or Hungarian ethnicity. The distribution of trait variations (stature, weight, and triceps, biceps, subscapular and suprailiac skinfold thicknesses) were studied by means of regression analysis, Box's test and the t-test (with LEVENE's test). The prepuberty-puberty sex differences and the frequency of obesity were estabilished.

Key words: children's development, sex differences, obesity, BMI

Introduction

The physical development of children is determined by endogenous and exogenous factors. Endogenous factors involve primarily the genetic characters (SUSANNE, 1977; MUELLER, 1983), which give potential bases for the growth and sexual maturation of the individual. Which of these possibilities are expressed and appear genotypically is determined by the exogenous environmental factors. From among the natural and social environmental factors (WOLANSKI, 1988), we emphasize here the socio-economic assets, laying stress on the role of the family and the quality of life (JOHNSTON et al., 1980; PAP et al., 1996).

Outstandingly important factors are the social status and life style of the children (primarily the nutritional habits), which play a decisive role in the evolution and arrangement of the fat tissues. One unfavourable result of overfeeding is the development of obesity, which may have undesirable consequences from a pathological aspect, e.g. the development of a diabetic state, bilestones or hypertension (BÍRÓ, 1990).

Obesity involves a pathologically increased fat content in the organism. Its existence is demonstrated by deviation of the body mass from that which normal for the given stature, age, constitution and racial qualities (MAGYAR, 1972; EIBEN, 1977; FARKAS, 1986). Its examination is most frequently based on the determination of skinfold thickness in various regions of the body. Obesity can be interpreted from various points of view. The cases can be grouped by means of indices, the basis of which are the weight and stature data. It may be calculated in various ways; accordingly, the categories are also based on different criteria:

1. The BROCA index and its modified variant (SZOLLÁR, 1988):
   weight (kg) = stature (cm) – 100, or
   (for females) stature (cm) – 100 – 10%
   (for males) stature (cm) – 100 – 5%
2. The obesity index (OKAYASU et al., 1994):
   found weight – standard weight (based on sex and stature)/standard weight
3. The LIVI index (KNUSSMANN, 1988):
   $[\sqrt[3]{\text{weight (g)}}$ /stature (cm)] x 10
4. The body mass index (KNUSSMANN, 1988) (BMI, QUETELET index, KAUPSCHER index):
   weight (g) / stature^2 (cm)
   weight (kg) / stature^2 (m) (KEYS et al., 1972; GYENIS, 1994)
5. Use of percentiles (WINICK, 1975)

Material and methods

The examinations involved 340 children, aged 7-15 yr, of Gypsy (76 boys and 67 girls) or Hungarian (96 boys and 106 girls) ethnicity. This is the age group that reacts most sensitively to the changes in the environmental factors. An examination of their metrical characters can therefore provide a picture of their socio-economic status. Sampling was performed at two places: Szalonna and Bódvaszilas (Bódva valley, Borsod-Abaúj-Zemplén County, North Hungary). The children were classified into two large groups: the group of Gypsy children, and the Hungarian children from Szalonna and Bódvaszilas.

The children were divided into only four age groups, since the numbers of children in the individual age groups were too low to provide statistically reliable data for intrapopulational analysis: age group I: 7-8 yr; age group II: 9-11 yr; age group III: 12-13 yr; age group IV: 14-15 yr. These corresponded to the start of sexual maturation, abrupt increases in the metrical characters and the menarcheal age. Detailed statistical analyses were performed by age groups, sexes and ethnic groups. The medians for menarche for European girls lie in the range 12-14 yr. As concerns the sexual maturation of Hungarian girls in the past 30-35 years, the reported median values were between 12.77 and 13.86 yr (DANKER-HOPFE, 1986. cit. EIBEN, BODZSÁR, FARKAS, PANTÓ, THOMA).

Six traits were examined: weight, stature and four skinfold thickness values: on the biceps, the triceps, the subcapula and the suprailiaca. For data regression analysis, BOX's test and the t-test (with LEVENE's test) were used. Processing was performed with the help of the SPSS/PC$^+$ program packet.

The different weight categories were established via the stature - weight relation studies (PAP et al., 1996), the results of the regression analysis of weight, the four skinfold thicknesses and the analysis of the median-interquartile ranges. Evaluation was performed with the help of the body mass index (weight (g)/stature^2 (cm)), the classification being based on the following categories :

very lean	≤1.80
lean	1.81-2.14
medium	2.15-2.56
stocky	2.57-3.04
obese	≥3.04

Results and discussion

Because of the lack of space, we shall omit a detailed presentation of the values obtained with the t-test (LEVENE'S test). The descriptive statistical analysis is illustrated for age group IV of the Hungarian and Gypsy children (see Tables 1 and 2). In the first and second age groups, there was no significant difference between the sexes in any of the traits in either ethnic group. In the first age group, the difference in the skinfold thickness on the triceps approached the significance level $p=0.05$ for the Hungarian children. In age group III, the increase in the metrical characters of the girls indicated the start of puberty and the beginning of sexual maturation; relative to the boys, significant differences can be demonstrated in all six traits, to the advantage of the girls ($p<0.05$ for the weight, stature and skinfold thickness on the biceps, and $p<0.01$ for the triceps, subscapular and suprailiac skinfold thicknesses). For the Gypsy children, only the subscapular skinfold thickness showed a significant difference ($p<0.05$), again to the advantage of the girls. Age group IV presents further changes: the boys reach the period of puberty, and there is an abrupt growth in stature and consequently in weight, whereas the skinfold thicknesses do not exceed the values for the girls. For the Hungarian children in the fourth age group, all differences were significant, except for weight. For the boys the stature ($p<0.01$), and for the girls the skinfold thicknesses ($p<0.01$ in all four cases) were higher. For the Gypsy children, neither the stature nor the weight differed significantly. On the other hand, very considerable differences in skinfold thickness were to be found, to the advantage of the girls ($p<0.01$).

Table 1. Descriptive statistics of the body measurements and skinfold thickness in Hungarian boys and girls in the Bódva valley (age group IV).

Variables	Sex	Mean	SD	SE of mean	Mean diff.	LEVENE's test	T-value	2-Tail sig.
Stature	Boys	165.7222	10.535	2.027	6.4279	F=2.861	2.66	.010
	Girls	159.2943	8.477	1.433		P= .096		
Weight	Boys	51.7222	10.015	1.927	3.3508	F=4.250	1.49	.142
	Girls	48.3714	7.713	1.304		P= .044		
Subscap. skinfold	Boys	7.4259	2.468	.475	-3.7169	F=5.148	-3.51	.001
	Girls	11.1429	5.053	.854		P= .027		
Suprail. skinfold	Boys	5.9630	2.410	.464	-4.5799	F=5.596	-4.10	.000
	Girls	10.5429	5.403	.913		P= .021		
Triceps skinfold	Boys	7.8889	3.479	.670	-5.1397	F=3.234	-5.31	.000
	Girls	13.0286	3.996	.675		P= .077		
Biceps skinfold	Boys	4.8704	1.929	.371	-4.8153	F=5.163	-5.54	.000
	Girls	9.6857	4.178	.706		P= .027		

In the course of data processing, the changes in each skinfold thickess were examined as a function of weight by means of regression analysis. This method is suitable for demonstrating the increases in the various metrical characters, the rate of increase and the relationship between the increases in the two traits. With boxplot diagrams, the changes in the skinfold thicknesses were examined relative to the increase in age. Figures 3 and 4 reveal not only the changes in the median values, but also the width and arrangement of the interquartile range, as well as the maxima, the minima and the extreme cases.

Table 2. Descriptive statistics of the body measurements and skinfold thickness in Gypsy boys and girls in the Bódva valley (age group IV)

Variables	Sex	Mean	SD	SE of mean	Mean diff.	LEVENE's test	T-value	2-Tail sig.
Stature	Boys	160.4100	9.551	3.020	7.0827	F= .034	1.72	.102
	Girls	153.3273	9.343	2.817		P= .856		
Weight	Boys	48.8500	10.236	3.237	3.5318	F=2.254	.93	.364
	Girls	45.3182	7.008	2.113		P= .150		
Subscap. skinfold	Boys	7.0000	1.414	.447	-5.2727	F=8.771	3.33	.004
	Girls	12.2727	4.819	1.453		P= .008		
Suprail. skinfold	Boys	5.4000	1.776	.562	-5.4182	F=7.221	4.03	.001
	Girls	10.8182	3.894	1.174		P= .015		
Triceps skinfold	Boys	6.5000	1.269	.401	-7.4091	F=9.437	6.45	.000
	Girls	13.9091	3.419	1.031		P= .006		
Biceps skinfold	Boys	5.0000	1.414	.447	-4.5455	F=1.590	5.39	.000
	Girls	9.5455	2.296	.692		P= .223		

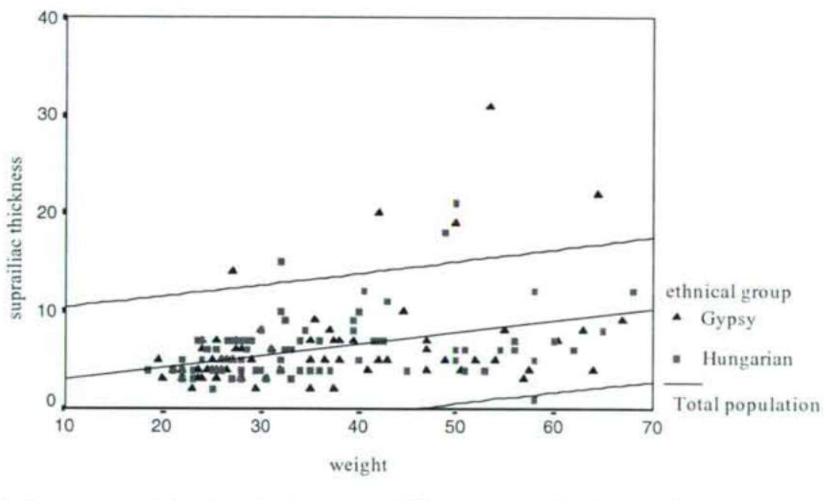

Fig.1. Linear regression of suprailiac skinfold thickness vs. weight of boys in the Bódva valley (all age groups).

The skinfold thickesses measured at four parts of the girls' bodies increased together with weight (e.g. Fig. 2; $Y'_H = 0.27x - 1.36$; $Y'_G = 0.37x - 4.30$); nevertheless, the gradient of the regression line indicating the correlation between the increase in the two traits was less steep than that obtained for the growth relation for stature – weight. In the case of the girls, with the help of the boxplot diagram (Fig. 4), an increase could be demonstrated for the growth of thickness of the suprailiac skinfold thickness with age in both ethnic groups, whereas no such unequivocal tendency was found for the other skinfold thicknesses. The increase in skinfold thickness was hardly influenced by rise in weight for the boys (e.g. Fig. 1; $Y'_H = 0.09x + 2.81$; $Y'_G = 0.15x + 0.94$). In fact, on the biceps and triceps the gradient of the linear regression line approximated to 0, which means that the weight had to or only a very slight influence on the change in skinfold thickness. This was confirmed by the boxplot analysis results (Fig. 3). The values of the median are consistently similar, independently of age, and are arranged nearly linearly. The interquartile ranges are extremely narrow, probably because the trait does not show great individual variability.

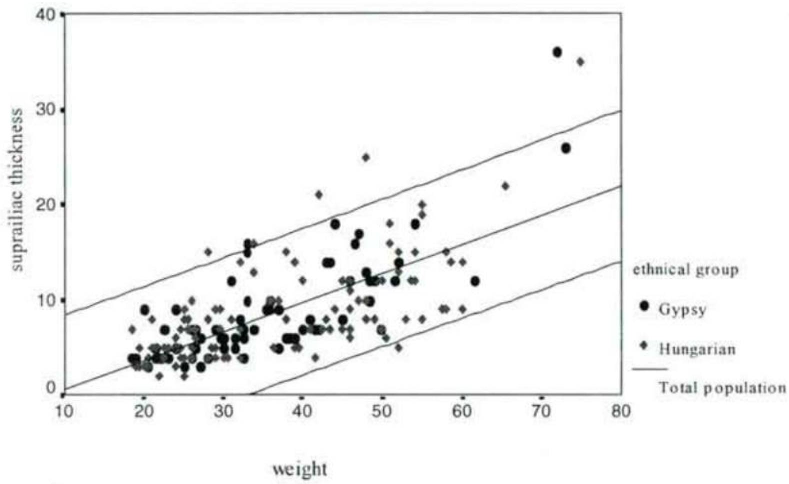

Fig. 2. Linear regression of suprailiac skinfold thickness vs. weight of girls in the Bódva valley (all age groups).

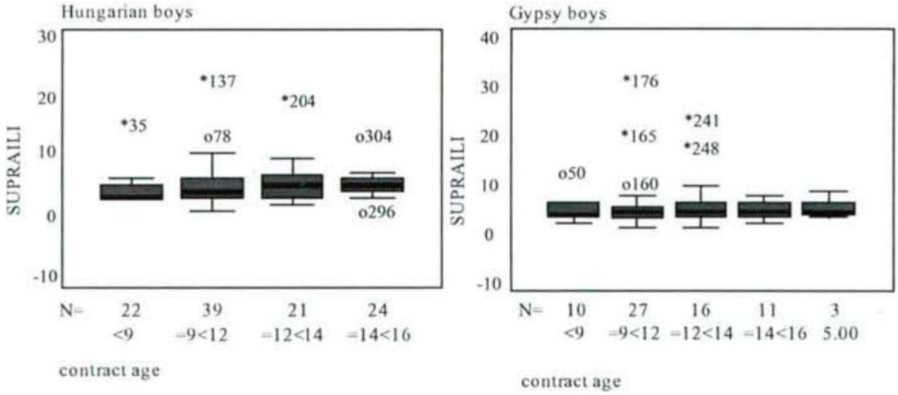

Fig. 3. Boxplot presentation of suprailiac skinfold thickness of boys in the Bódva valley.

Through endogenous and exogenous impacts the individual becomes a carrier of individual characters. In addition to data processing at the microregion and population levels, therefore the management of data at the individual level is inevitable, since this is the only possibility of selecting the obese children, and their data can be interpreted only in this way. The pinpointing of potentially obese children was successful with the joint application of the above-mentioned methods. For assessment, the body mass index was used. Only those were regarded as obese who belonged in the two top body mass index categories (stocky or obese), and they were involved in the percentual evaluation. Table 3 reports the frequency data broken down into ethnic groups, sexes and age groups. None of the Hungarian boys belonged in the two body mass categories mentioned. In the other cases, each percentual value means one child among those of the given age. In the overwhelming majority of cases, these subjects fell into the stocky category, with the exception of a 16-year-old Gypsy girl, who was in the fifth (obese) group.

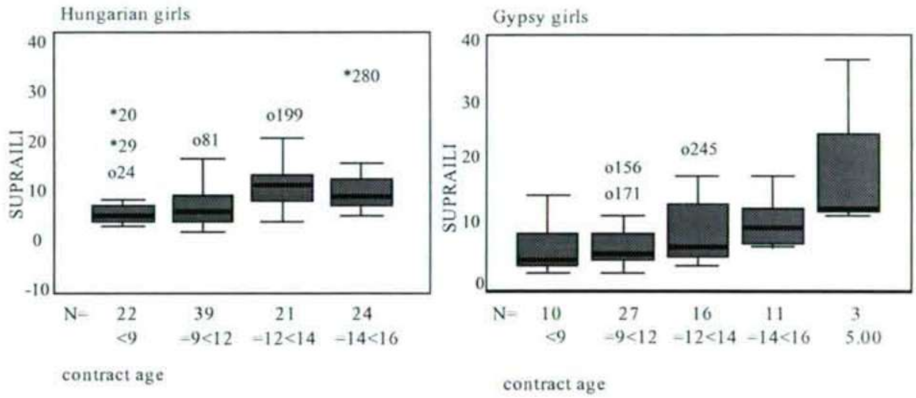

Fig. 4. Boxplot presentation of suprailiac skinfold thickness of boys in the Bódva valley.

Conclusion

The statistical evaluation of the data on the Bódva valley children revealed that weight, in general, has no all or only a slight influence on the changes in the skinfold thickness values. This can mainly be observed in the case of boys. It is correlated with the circumstance that the age of the children does not notably affect the thicknesses of the skinfolds. For the girls, the thickness of the suprailiac skinfold is most markedly dependent on age, due to the start of sexual maturation, which triggers the process of feminine development, and the evolution of the secondary sex characters, which involves the accumulation of fat tissues around the hips. The t-test was highly suitable for following the presence of sex characteristics from childhood through prepuberty up to the beginning of puberty. The period of puberty falls between 12 and 13 years for girls, whereas for boys there is a delay of about 2-3 years. The comparisons in age group IV demonstrate that the skinfold thickness is significantly greater in every case for girls than for boys, and this difference as a sex characteristic probably persists after puberty. The increase in the thickness of the suprailiac skinfold results in the development of the centralized fat tissue pattern.

Table. 3. Frequency of obesity in the Bódva valley

	Hungarian boys			Gypsy boys			Hungarian girls			Gypsy girls		
	All	Obese	Obese	All	Obese	Obese	All	Obese	Obese	All	Obese	Obese
Age	n	n	%	n	n	%	n	n	%	n	n	%
7	3	-	-	3	-	-	7	1	14.28	1	-	-
8	11	-	-	7	-	-	15	-	-	9	-	-
9	13	-	-	10	-	-	16	-	-	7	-	-
10	18	-	-	13	-	-	10	-	-	6	-	-
11	14	-	-	8	1	12.5	13	1	7.69	14	-	-
12	4	-	-	8	-	-	12	1	8.33	11	-	-
13	11	-	-	14	1	7.14	9	-	-	5	1	20
14	12	-	-	7	-	-	17	1	5.88	7	-	-
15	5	-	-	3	-	-	7	-	-	4	-	-
16	0	-	-	3	-	-	0	-	-	3	1	33.3
All	91	-	0%	76	2	2.63%	106	4	3.77%	67	2	2.98%

Acknowledgement

This study was supported by the National Scientific Research Foundation (OTKA grant no. T 016110).

References

BÍRÓ, GY. (1990): Nutrition and cardiovascular risk: the Hungarian experience. - Acta Cardiologica *45*, 3-14.

DANKER-HOPFE, H. (1986): Menarcheal age in Europe. - Yearbook of Phys. Anthropol. *29*, 81-112.

EIBEN, O. (1977): Hungarian investigations concerning growth and development and the variation of physique. In: EIBEN, O. (ed.): Growth and development; Physique. - Symp. Biol. Hung. *20*, 11-15.

FARKAS, GY. (1986): Délalföldi 10-18 évesek testi fejlettsége és a leányok menarchekora. - Budapest (DSc thesis).

GYENIS, GY. (1994): Az obesitas gyakorisága magyar egyetemi hallgatókon. - Anthrop. Közl. *36*, 59-67.

KEYS, A., FIDANZA, F., KARVONEN, M. J., KIMURA, N. and TAYLOR, H. L. (1972): Indices of relative weight and obesity. - J. Chron. Dis. *25*, 329-343. (cit. in: GYENIS, 1994)

JOHNSTON, F. E., SCHOLL, T. O., NEWMAN, B. C., CRAVIOTO, J. and DE LICARDIE, E. R. (1980): An analysis of environmental variables and factors associated with growth failure in a Mexican village. - Hum. Biol. *52*, 627-637.

KNUSSMANN, R. (1988): Somatometrie. In: KNUSSMANN, R. (ed.): Anthropologie. Handbuch der vergleichenden biologie des Menschen. - Gustav Fischer, Stuttgart, New York, 232-283 pp.

MAGYAR, I. (1972): Obesitas. In: ÁKOS, K. and RÉVÉSZ, Gy (eds): Orvosi lexikon. - Akadémiai Kiadó, Budapest, 758-759 pp.

MUELLER, W. H. (1983): The genetics of man fat. - Yearbook of Phys. Anthropol. *26*, 215-230.
OKAYASU, T., AYA, H., OBARA, M., OKABE, A. and ARASHIMA, S. (1994): Longitudinal analysis of obesity in Japanese children and youth. In: EIBEN, O. (ed.): Humanbiol. Budapest. Auxology' 94. Children and youth at the end of the 20th century. - Budapest, 549-553 pp.
PAP, M., SZABÓ, GY. and GÖNCZY-SZABÓ, T. (1996): Population-biological feature of human populations, physical development of children and environmental effects. - 10th Congress of the European Anthropological Association. Program Abstracts. Brussels, 54 p.
SUSANNE, C. (1977): Heritability of anthropological characters. - Hum. Biol. *49*, 573-580.
SZOLLÁR, L. (1988): Az elhízás. In: HÁRSING, L. (ed.): Kórélettan. - Medicina, Budapest, 211-228 pp.
WINICK, M. (1975): Childhood obesity. - John Wiley & Sons.
WOLANSKI, N. (1988): Ecological aspects of the growth and development of man. - Colleg. Anthrop. *12*, 1-12.

ACTA BIOL. SZEGED. 42, pp. 315-319 (1997)

SECULAR TRENDS IN EASTERN HUNGARY

T. G. SZABÓ and K. NYILAS

Zoological Department, Bessenyei György Teachers' Training College, H-4401 Nyiregyháza, Sóstói ut 31/B, Hungary

(Received: December 10, 1996)

Abstract

Our projects have for several decades included examinations of the features of growth and physical development among children of different ages of different genetic and exogenous origins. This paper reports on the physical development of 7-14-year-old children in Szabolcs-Szatmár-Bereg County, comparing the differences in the different geographical regions of the county. The research on the 7-14-year-olds in Téglás since the 1950s best reflects the main features of the secular trend. The biological research among college students since 1963 also follows the secular trend according to the social changes. The secular trend among mildly mentally handicapped children can be seen from the research started in 1976.

Key words: secular trend, growth and development: height, weight, chest circumference.

Introduction

The accelerations in growth and body development processes are well known from publications on human biology (EIBEN, 1988, 1989; FARKAS, 1989; KÁDÁR and VÉLI, 1977; GYENIS, 1981; MÉSZÁROS et al., 1982; TANNER, 1986; TOBIAS, 1985; VÉLI, 1967). We assign important roles to the narrower and wider environmental background in the self-assertion of the genetic basis of growth.

Why have we chosen such a well-known phenomenon as the area for our examinations?

The eastern part of Hungary is the most underdeveloped region of the country; it has inherited a centuries-old economic and social backwardness. In recent decades, due to the ongoing social development, a favourable situation has evolved, but the backwardness is still significant in comparison with other parts of the country.

Today the rate of unemployment is among the highest, the rate of employment is the lowest, and the real income falls far short of the national average here.

Accordingly, we conceive the possibility of stronger changes of the social effects in respect of body development. During the previous 50 years, a definite antropological programme involving numerous experiments was carried out on this geographical area and its villages (RAJKAI, 1963; 1965). This greatly assisted our work, which may be regarded as a continuation of the foregoing work.

Materials and methods

The basic antropometric list contains 21 body and head measurements. In this research we present an analysis of the height, weight and chest circumference, measurred by internationally standardized means in accordance with the internationally accepted standards described by MARTIN and SALLER (1957) and the recommendations of the International Biological Programme (TANNER et al., 1969). We also examined the socio-economic background of the children. The statistical parameters were calculated on an IBM computer.

Groups participating in this research:

7-14-year-old children at Téglás, a Hajdú village exhibiting significant social and economic changes during the past 50 years.

Female students at the Bessenyei György Teachers' Training College in Nyíregyháza during the past 30 years.

Mentally deficient children in Szabolcs-Szatmár-Bereg County in the past 10 years. Among mildly deficient children, the negative effects of the enviromental factors play a role in the formation of the deficiency.

Results and discussion

The children of a typically agricultural Hajdú village, Téglás, which has recently become a town, have displayed a strong tendency to lerger growth in the past 50 years. This is reflected by the changes in average height for both boys and girls for 1952, 1962, 1982 and 1992 (Table 1). The children of Téglás reached the national growth level for 1986 (EIBEN, 1989) in 1992. In recent decades, the increase in weight especially for girls, but also for boys, has become very explicit (Table 2).

The circumference and width measurements (chest circumference and shoulder width) do not reveal such marked changes as those in height and weight. We recently enlarged our anthropological programme with examinations of somatotype among children at Téglás. As time passes, besides the increase in heterogeneity, it is characteristic that the children's body type changes from ectomorphic to central. Up to the ages of 7-10, for both sexes the mesomorphic from dominates, but later, due to the development process, the sexual difference appears. (Among girls the endo-mesomorphic form, and among boys the ectomorphic form becomes more characteristic).

Body development measurements among the mentally deficient children in Szabolcs-Szatmár-Bereg County showed a positive secular trend too between 1982 and 1992. The height exhibits the most positive increase (Table 3). Howerer, the heigth of both girls and boys falls behind both the national and the county data (EIBEN, 1989; NYILAS, 1984). The circumference and width measurements follow the positive secular trend. The weight falls below the normal figures for both sexes (Table 5). The average stretching and growing changes are not followed. These children display a relatively thinn body type, mainly due to the less favourable social background.

Since 1986 we have continued the experiments started in 1963 (RAJKAI, 1963) among the female students at the Teachers' Training College. The most intensive change has occurred in the height, demonstrating the secular trend in this age group (Table 5).

Table 1. Heights of boys and girls in Téglás in 1952, 1962, 1982 and 1992.

Age (years)	1952	1962		1982		1992	
	$\bar{x}$	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$
				Boys			
7	115.03	117.53	0.617	112.31	0.400	124.27	1.300
8	120.13	112.14	0.685	127.07	0.403	127.75	0.960
9	125.51	126.88	1.979	129.10	0.456	132.53	1.115
10	129.91	131.60	1.918	135.60	0.450	143.81	1.040
11	134.24	136.65	1.191	142.80	0.590	147.12	1.001
12	139.50	132.76	1.286	146.57	0.415	148.78	0.780
13	143.35	144.41	1.132	154.23	0.438	152.96	0.980
14	147.93	148.00	1.665	158.83	0.611	169.86	0.931
				Girls			
7	113.00	116.30	0.650	120.52	0.342	121.93	1.720
8	118.55	122.00	0.668	123.45	0.423	128.50	1.190
9	123.72	127.10	0.880	130.72	0.337	135.36	1.510
10	127.95	130.98	0.987	136.25	0.330	141.06	1.550
11	133.32	135.36	1.533	142.58	0.356	142.28	2.800
12	138.71	143.77	1.176	146.59	0.462	149.46	1.080
13	143.96	147.56	1.005	154.28	0.390	154.16	1.090
14	147.67	153.55	1.151	156.52	0.370	158.37	0.870

Table 2. Weights of boys and girls in Téglás in 1952, 1962, 1982 and 1992.

Age (years)	1952	1962		1982		1992	
	$\bar{x}$	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$
				Boys			
7	19.77	20.83	0.324	22.70	0.283	25.42	0.78
8	21.77	23.21	0.330	24.887	0.365	26.61	0.70
9	23.51	25.48	0.540	28.052	0.288	28.67	0.64
10	26.48	28.90	2.337	29.455	0.399	34.57	1.47
11	28.93	32.06	1.100	34.22	0.512	35.98	1.27
12	31.28	34.62	1.050	37.287	0.390	41.44	1.26
13	33.62	35.79	0.846	45.456	0.483	42.74	1.21
14	37.07	40.17	1.331	45.534	0.558	50.67	1.43
				Girls			
7	19.14	20.75	0.343	21.877	0.293	24.06	0.980
8	21.39	22.57	0.374	26.641	0.283	27.80	1.470
9	24.89	25.85	0.529	26.820	0.394	30.32	1.160
10	26.62	27.57	0.694	26.973	0.349	35.03	1.48
11	27.68	31.67	1.310	34.669	0.363	36.27	1.25
12	31.00	35.41	1.015	36642	0.456	41.81	1.96
13	36.68	39.16	0.877	14.051	0.415	45.63	1.52
14	39.11	47.24	1.179	47.614	0.382	50.33	1.26

The weight and circumference and width measurements are increasing continuously, and these girl college students today have a proportionate physicque (Table 5).

Table 3. Heights of mentally deficient boys and girls in 1982 and 1992.

Age (years)	1982		1992	
	$\bar{x}$	s	$\bar{x}$	s
			Boys	
7	-	-	-	-
8	122.03	8.64	123.38	8.29
9	128.34	6.96	130.04	8.69
10	131.49	6.02	133.92	6.75
11	138.29	8.97	134.52	5.59
12	143.31	8.35	143.76	6.05
13	148.94	8.66	158.77	6.48
14	164.76	8.85	153.22	8.80
15	160.65	7.70	158.51	8.37
			Girls	
7	120.75	15.40	118.33	5.26
8	120.63	5.09	121.65	6.31
9	152.05	8.33	133.24	8.87
10	133.35	7.03	133.24	8.87
11	140.53	8.10	136.55	5.42
12	143.47	10.04	148.31	6.97
13	150.59	7.90	154.48	10.9
14	161.51	7.39	154.81	8.14
15	154.89	7.39	154.81	6.49

Table 4. Weights of mentally deficient boys and girls in 1982 and 1992.

Age (years)	1982		1992	
	$\bar{x}$	s	$\bar{x}$	s
			Boys	
7	-	-	-	-
8	22.99	4.14	21.60	3.21
9	25.04	3.49	26.30	8.170
10	27.34	4.47	29.13	5.59
11	31.51	7.35	27.75	3.86
12	35.01	6.56	32.29	6.68
13	38.38	9.04	36.75	4.86
14	42.70	9.01	40.31	7.61
15	48.65	9.28	52.13	19.41
			Girls	
7	24.08	10.81	19.00	4.52
8	22.20	3.60	20.50	1.73
9	23.58	3.94	21.60	1.82
10	28.48	5.82	29.13	9.19
11	32.77	8.28	25.00	2.16
12	35.68	8.52	36.00	5.93
13	42.97	10.53	42.67	9.27
14	46.63	9.61	49.33	9.07
15	46.21	7.94	49.27	7.99

Conclusion

In eastern Hungary, the social and economic development, though slow, is favouring the childhood and juvenile body development. This trend can also be seen among mildly deficient children from an unfavourable social and economic background.

Table 5. Heights and weights of girl students in 1964, 1975 and 1985.

Age	1963/64 RAJKAI	1974/75 G. SZABÓ-NYILAS			1985/86 G. SZABÓ-NYILAS		
(years)	19-23	20	21	22	20	21	22
Height (cm)	160.54	163.33	162.78	165.0	163.99	166.0	162.36
s	4.52	5.29	5.48	7.72	6.51	6.76	2.39
Weight (kg)	55.24	55.98	54.61	56.41	56.9	58.82	54.75
s	6.046	5.88	7.50	7.68	7.60	6.61	5.06

References

EIBEN, O. (1988): Secular growth changes in Hungary (in Hungarian). - Humanbiol. Budapest. Suppl. *6*. 133.
EIBEN, O. (1989): Secular trend in Hungary. - Humanbiol. Budapest. Suppl. *19*. 161-168.
EIBEN, O. (1989): The Hungarian national growth study. - Humanbiol. Budapest. Suppl. *21*.
FARKAS, GY. (1989): A serdülés szekuláris trendjének változása hazánkban. - Fodor József Iskolaegészs. T. Vándorgyűlése, Kaposvár *7*.
GYENIS, GY. and TILL, G. (1981): Magyar egyetemi hallgatók testmagassága és testsúlya. - Antrop. Közl. *25*, 17-23.
KÁDÁR, P. and VÉLI, GY. (1977): A szekuláris trend 100 éves Somogy megyében. - Antrop. Közl. *21*, 93-100.
MARTIN, R. and SALLER, K. (1957): Lehrbuch der Anthropologie I. - Gustav Fischer Verlag, Stuttgart.
MÉSZÁROS, J., FRENKL, R., SZMODIS, I. and MOHÁCSIJ, J. (1982): A szekuláris trend vizsgálata a Testnevelési Főiskolára jelentkezett nőkön és férfiakon. - Sportorv. Szemle *23*, 97-102.
NYILAS, K. (1984): A rétközi általános iskolai tanulók néhány testmérete. - Acta Acad. Paed. Ny.
RAJKAI, T. (1963): A téglási gyermekek embertani vizsgálata az 1963 évben. - Acta Biol. Debrecen. *2*, 103-112.
RAJKAI, T. (1965): A nyíregyházi felsőoktatási intézmények női hallgatóinak testfejlettsége. - Acta Acad. Paed. Ny. *1*, 189-197.
TANNER, J. M., HIERNANX, J. and JARMAN, S. (1969): Growth and physique studies. In: WEINER, J. S. and LOURIE, J. A. (eds): Human biology - A guide to field methods. - IBP Handbook *9*. Blackwell Scientific Publishers, Oxford - Edinburg, 1-76 pp.
TANNER, J. M. (1986): Growth as a mirror of the condition of society: Secular trends and class distinction. In: DIMIRJIAN and BRAUET DUBUC, M. (eds): Human Growth: A multidisciplinary review. - Taylor and Francis, London - Philadelphia, 3-34 pp.
TOBIÁS, P. (1985): The negative secular trend. - J. Human Evolution *14*, 347-356.
VÉLI, GY. (1967): Az akceleráció a felszabadulás előtt és után. - Antrop. Közl. *11*, 25-30.

ACTA BIOL. SZEGED. 42, pp. 321-325 (1997)

CORRELATION SYSTEM OF HEAD MEASUREMENTS AND THEIR INDICES

K. SZILÁGYI, L. SZATHMÁRY and ZS. GUBA

Department of Human Biology, Lajos Kossuth University, Debrecen, H-4010, P.O.B. 6, Hungary

(Received: December 20, 1996)

Abstract

The correlation structure of head measurements and indices derived from them was analysed. The aim was to establish the prospective value of a joint investigation of measurements and indices in multivariate analysis. 9 head measurements on a North Hungarian sample (169 males and 211 females) and 9 indices derived from them were subjected to principal component analysis. This multivariate approach was found to yield indices which do not afford new information on population structure, since they do not compose an independent factor but are always related to the absolute measurements serving as the basis of their calculation. It seems that the use of several indices does not allow the detection of correlations existing among variables in an exact manner. There is no significant difference between the results yielded by the sexes. This observation may suggest a considerable change for generalization.

Key words: head measurements, indices, correlation

Introduction

A frequent question in the literature is whether, besides the analysis of a correlation system of measurements, it is worth analysing the correlation system of their indices; can this variant in the method provide new information on the structure of the population?

The present paper deals with the correlation system of absolute head measurements and the indices derived from them.

Material and method

The problem was investigated by using a sample from North Hungary (167 adult males and 211 adult females). The population originated from 10 villages in the Erdőhát region (Csaholc, Gacsály, Kishódos, Kisnamény, Kisszekeres, Méhtelek, Nagyhódos, Tisztaberek, Túrricse and Vámosoroszi), which include villages of both an endogamous and an exogamous character (SZILÁGY et al., 1993). The average sampling rate was 8.4%. The most widely used measurements and indices were chosen (Table 1). The correlation matrix of the total of 18 variables was analyzed by the principal component method for both sexes separately, by the varimax rotated method, omitting KAISER's normalization. The correlation system of these 18 variables is presented by hierarchic clustering as well; in accordance with the absolute values of the loadings of the rotated factor matrix, the system was prepared by the average linkage (within-group) method based on the Euclidean distance.

Table 1. Measurements and indices used.

Martin no.	Measurement	Martin no.	Index
1	head length	3/1	cephalic index
3	head width	3/16	height-width index of the head
4	least frontal breadth	4/3	forehead-head width index
6	bizygomatic breadth	4/6	forehead-face width index
8	bigonial breadth	6/3	face-head width index
13	nose breadth	8/6	mandible-face width index
16	total head height	13/21	height-width index of the nose
18	total face length	16/1	height-length index of the head
21	nose height	18/6	morphological face index

Results

Among males, the 18 variables formed 6 factors with an eigenvalue over 1.0, covering together 90.2 % of the total variance. Into the first factor, the absolute values (6, 8) and indices (8/6, 6/3, 4/6 and 18/6) describing the face width are loaded. The second factor is characterized by height dimensions (16, 18, 21 and 16/1). The third factor involves the head width (3, 3/1 and 3/16), the fourth the nose width (13/21 and 13), the fifth the forehead width (4/3 and 4) and the sixth the head length (Table 2).

Table 2. Rotated factor matrix for males.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
8/6	.97908*	-.02532	.02924	.02348	.03980	-.04850
4/6	.95776*	-.12970	-.01112	-.01818	.16379	-.04993
6/3	-.93272*	.13387	-.14847	-.00477	.22353	.04697
6	-.90355*	.17841	.22903	.04184	.23431	.14365
18/6	.87693*	.20361	-.19092	-.20364	-.22052	-.04533
8	.76445*	.17413	.25735	.11321	.28123	.07270
16	-.06771	.85907*	.04711	.22266	.20642	.07076
18	-.11404	.79138*	.01768	-.31495	-.02547	.19746
16/1	.04949	.74083*	.00288	.04534	.04360	-.65161
21	-.20880	.52944*	-.02451	-.51447	-.11962	.16529
3	-.06990	.14150	.92540*	.12968	.08363	.26111
3/1	.03909	.05079	.89272*	-.03006	-.06799	-.42882
3/16	-.00245	-.56939	.77114*	-.05343	-.10152	.16897
13/21	-.03180	-.07026	.04057	.97367*	.04334	.09242
13	-.19236	.33971	.03412	.70550*	-.05609	.23162
4/3	-.07083	.02669	-.40542	-.02415	.88039*	.00064
4	-.12004	.14873	.42715	.08409	.83512*	.22963
1	-.14678	.11228	.04784	.20675	.19829	.88706*

Since we were interested in the degree of correlation between the variables, and not in the direction of the correlations, we clustered the absolute values of the loadings of the rotated factor matrix. The dendrogram is depicted in Fig. 1.

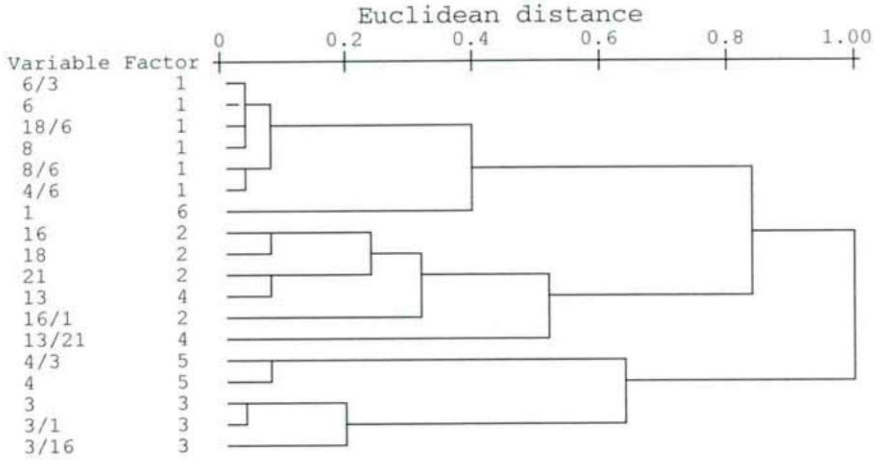

Fig. 1. Dendrogram using average linkage (within-group) for males.

Table 3. Rotated factor matrix for females.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
8/6	.96050*	-.00725	.08582	.11520	-.01605	-.02812	.01922
6/3	-.94072*	-.15274	.09426	.02846	.17470	.01120	.02911
4/6	.93413*	-.02874	-.02639	.01431	.31721	.00928	-.01170
6	-.91102*	.24884	.10517	.18054	.18128	.04895	.03295
18/6	.87822*	-.15313	.13914	.06530	-.12595	.33851	-.01751
8	.74780*	.16937	.22798	.30280	.11917	.01194	.08733
3	-.03208	.92253*	.04258	.35407	.05257	.08122	.01041
3/1	-.06580	.86602*	.03904	-.48001	-.09450	-.04896	-.03859
16/1	-.00720	.07829	.93057*	-.34337	.02297	-.00241	-.05591
16	.03420	.05570	.84893*	.45841	.15917	.11209	-.00452
3/16	-.04654	.66222	-.72359*	-.13154	-.09689	-.03609	.01205
1	.04557	-.02059	.00190	.96379*	.16924	.14605	.05654
4/3	-.04171	-.36301	.08508	.00943	.92001*	.06121	.04623
4	-.05727	.33175	.10951	.26524	.88364*	.11993	.04892
21	.02702	.00675	-.05108	.05922	.15294	.93101*	-.03804
18	.14053	.05502	.39151	.31938	.02370	.71997*	.02945
13	-.00172	-.00926	-.04634	.05986	.09461	.25965	.94866*
13/21	-.01953	-.00673	-.01085	.01066	-.01890	-.46531	.87524*

For the females, 95.1% of the total variance can be explained by 7 factors with eigenvalues over 1.0. In the first factor, the same variables are loaded as among males (6, 8, 6/3, 4/6, 8/6 and 18/6), in the second the head width (3 and 3/1,), and in the third the head height (16) and its indices (16/1 and 3/16). The fourth factor, like the sixth factor of males, represents only the head length (1), the fifth the forehead width (4 and 4/3), the sixth the height of the face and of the nose (18 and 21), and the seventh the nose width (13 and 13/21) (Table 3).

Clustering the variables in accordance with the principles used to study the males and described above afforded the results represented in the dendrogram to be seen in Fig. 2.

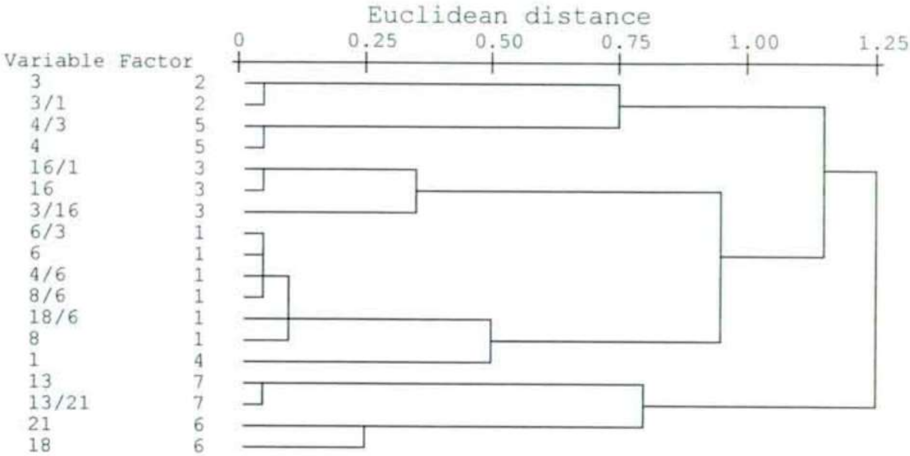

Fig. 2. Dendrogram using average linkage (within-group) for females.

Overall, our opinion on the correlation system of variables within the population investigated can be summarized as follows:

The indices created from measurement no. 6 were situated in the same factors as for measurements no. 6. The correlation between variables 4-4/3 and 13-13/21 was very close within both sexes. Measurement no. 1 has an independent position for both sexes. Among males, index 3/16 shows a correlation rather with the head width; among females, it is correlated the head height. The dendrograms in Figs 1 and 2 demostrate the groups of variables described above. Among males, measurement no. 13, belonging to factor 4, is interpolated in the group of variables of factor 2. This is due to the loading of measurement no. 13 being relatively high (0.34) for factor 2 as well (Table 2).

Conclusions

An analysis of the correlation structure of head measurements and head indices revealed that the indices never formed an independent factor, but rather formed groups related to the absolute values which served as the basis for their calculation. This probably means that the correlation between the indices, describing similar relations, is not closer than the correlation with the absolute measurements. This is true even if an attempt is made to analyse several indices derived from the same measurement in the manner applied to measurement 6 and the indices related to it (6/3, 4/6, 8/6 and 18/6). Thus, if the original measurements and their indices are investigated together, the same information is repeatedly inserted into the system via several variables, and, without a knowledge of the correlation conditions, this may lead to significant distortion. At the same time, in the knowledge of the correlation conditions, the indices become unnecessary, because they do not contain essential new information on the system. Different applications of the indices may conceal or distort the correlation system among measurements - obviously probably because the correlation between the different dimensions and the indices derived from them is closer than the simple correlation of the measurements. There is no significant difference between the results yielded by the two sexes. This may suggest that the phenomenon observed here is not an individual one, but rather a more general one.

References

MARTIN, R. (1928): Lehrbuch der Anthropologie. - Fischer, Jena, 2. Aufl. 1. Bd.

SZILÁGYI, K., SZATHMÁRY, L. and TÓTH, I. (1993): A szatmári Erdőhát tíz népességének cephalometriai vizsgálata (Cephalometric Examinations on Ten Populations in Erdőhát in Szatmár County). - JAMÉ *33-35*, 369-387.

ACTA BIOL. SZEGED. 42, pp. 327-331 (1997)

STUDY OF PHYSIQUE IN THYROID PATIENTS

G. TÓTH[1] and M. BARANYAI[2]

[1]*Berzsenyi Dániel Teachers' Training College, H-9701 Szombathely;*
[2]*Markusovszky County Hospital, Szombathely, Hungary*

(Received: December 20, 1996)

Abstract

Clinical examinations of physique, involving 20 parameters of body measurements, were made on 57 female thyroid patients in Western Hungary. The proportions were studied with the method of ROSS and WILSON (1974) while the procedure of HEATH and CARTER (1967) was used for somatotyping. The somatotype of hyperthyroid patients was 6.56-5.23-1.42. The somatotype of hypothyroid patients was 7.17-5.96-1.27. It is due to modern hormone therapy that the difference in physique related to the two disorders is significantly decreased.

Key words: Hyperthyroidism, hypothyroidism, clinical science of physique, somatometry

Introduction

The clinical science of physique, as part of human biological examinations, is more intimate than the applied science of physique (EIBEN, 1992). New perspectives may be discerned from new types of examination methods (TÓTH, 1996). It has a double aim: to study physique as a part of morphological constitution (EIBEN,1972), which may predispose to some diseases (PADOS et al., 1988), and to follow up the changes in physique caused by diseases. The theme and the investigation topics are based on from applied researches, from the middle of the 20th century (BUDAY, 1943; CURTIUS, 1954). Thyroid disorders are more frequent in women; BUDAY deals with the functional problems and the changes in physique in detail (BUDAY, 1943). Even clinical practice regards morphological changes as characteristic symptoms (MAGYAR and PETRÁNYI, 1986). The present study takes the results of modern hormone therapy into consideration and reports data on the physique of patients followed up in Western Hungary.

The examinations were carried out within the scope of a special Thyroid Patients' Consultation of the Markusovszky Hospital and Outpatient Polyclinic in Vas County in precisely diagnosed 26-69-year-old patients (mean: 48.7 years). The purified sample consisted of the data on 57 patients followed up (hyperthyroidism: n = 31, hypothyroidism: n = 26). All of them belonged in the Hungarian population and

Europid race. 20 body measurements were made on each patient followed up. The method of the examination was based on the measurement technique of MARTIN and SALLER (1957), with consideration to the recommendations of the IBP/HA (TANNER et al., 1969). The changes in proportionality were analysed by comparing the data with those of the Unisex Human Phantom (ROSS and WILSON, 1974). Somatotyping (SHELDON et al., 1940) was performed according to the method of HEATH and CARTER (1967).

Results and Discussion

The results of anthropometric examinations are shown in Tables 1 and 2. Among the body proportions, attention should be paid to the high proportional values of the chest circumference and some skinfolds, and also the marked negativity of the femoral circumference, in both groups examined. Analysis of these body proportions should be a topic of further studies.

Somatotypes are to be found in the meso-endomorphic field. The mean is 7.17-5.96-1.27 in hypothyroid patients, and 6.56-5.23-1.42 in hyperthyroid patients (Figs 1 and 2). The results of the study reveal that the concomitant morphological symptoms have lessened appreciably in both thyroid disorders. The reason might be the modern hormone therapy, which (besides normalizing the thyroid activity) prevents or eliminates changes in physique.

Table 1. Means, standard deviations, and standard errors of body measurements investigated in hyperthyroid patients.

Body measurements investigated	$\bar{x}$	s	$s_{\bar{x}}$
Weight (kg)	65.71	12.22	2.19
Sitting height (cm)	84.95	4.80	0.86
Height (cm)	160.4	6.74	1.21
Height of acromion (cm)	133.27	6.35	1.14
Height of dactylion (cm)	61.01	12.28	2.20
Height of iliospinale (cm)	91.75	4.39	0.79
Neck circumference (cm)	35.96	3.03	0.54
Chest circumference (cm)	90.28	7.42	1.33
Upper arm circumference (relaxed) (cm)	27.03	3.68	0.66
Upper arm circumference (bent) (cm)	27.99	3.61	0.65
Thigh circumference (cm)	46.57	5.85	1.05
Calf circumference (cm)	36.00	3.79	0.68
Bicondylar width of humerus (mm)	65.4	5.20	0.93
Bicondylar width of femur (mm)	99.73	10.71	1.92
Medial calf skinfold (mm)	21.27	8.35	1.50
Triceps skinfold (mm)	22.00	6.71	1.20
Biceps skinfold (mm)	14.73	6.31	1.13
Subscapular skinfold (mm)	19.68	8.34	1.50
Abdominal skinfold (mm)	22.31	8.28	1.49
Suprailiac skinfold (mm)	25.57	6.91	1.24

Table 2. Means, standard deviations, and standard errors of body measurements investigated in hypothyroid patients.

Body measurements investigated	$\overline{x}$	s	$s_{\overline{x}}$
Weight (kg)	71.92	15.3	3.00
Sitting height (cm)	85.69	2.85	0.56
Height (cm)	160.27	4.32	0.85
Height of acromion (cm)	132.86	4.36	0.85
Height of dactylion (cm)	63.72	2.95	0.58
Height of iliospinale (cm)	90.70	3.55	0.70
Neck circumference (cm)	35.77	2.76	0.54
Chest circumference (cm)	95.16	9.26	1.82
Upper arm circumference (relaxed) (cm)	29.32	4.57	0.90
Upper arm circumference (bent) (cm)	30.05	4.45	0.87
Thigh circumference (cm)	49.43	6.37	1.25
Calf circumference (cm)	37.46	3.58	0.70
Bicondylar width of humerus (mm)	66.50	6.11	1.20
Bicondylar width of femur (mm)	100.92	9.64	1.89
Medial calf skinfold (mm)	21.19	8.31	1.63
Triceps skinfold (mm)	23.77	8.16	1.60
Biceps skinfold (mm)	16.65	7.77	1.52
Subscapular skinfold (mm)	22.50	9.03	1.77
Abdominal skinfold (mm)	24.31	9.05	1.77
Suprailiac skinfold (mm)	28.69	7.12	1.40

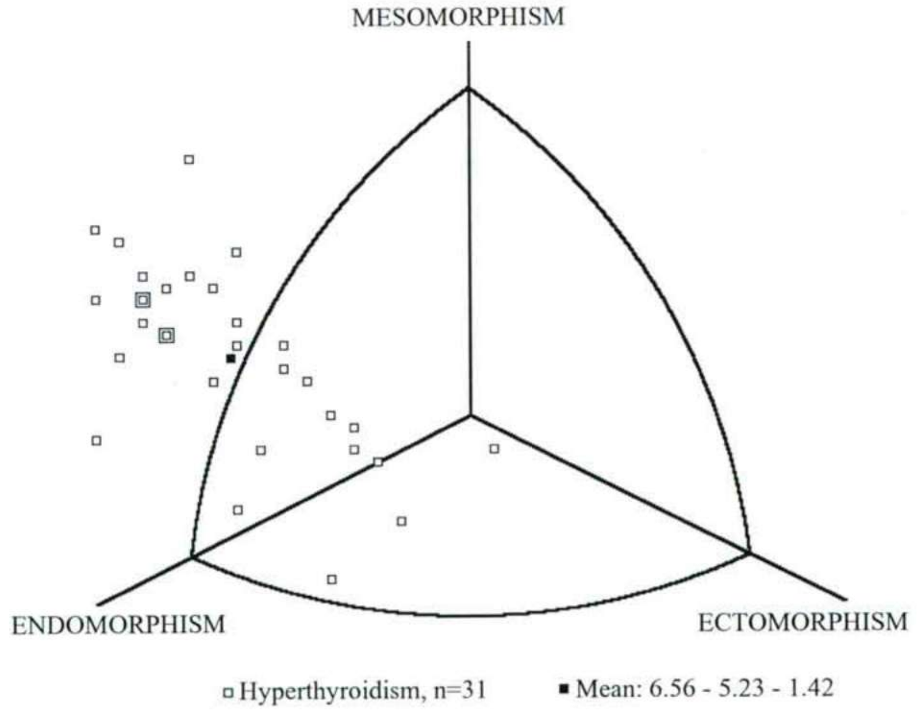

Fig. 1. Somatotypes of hyperthyroid patients.

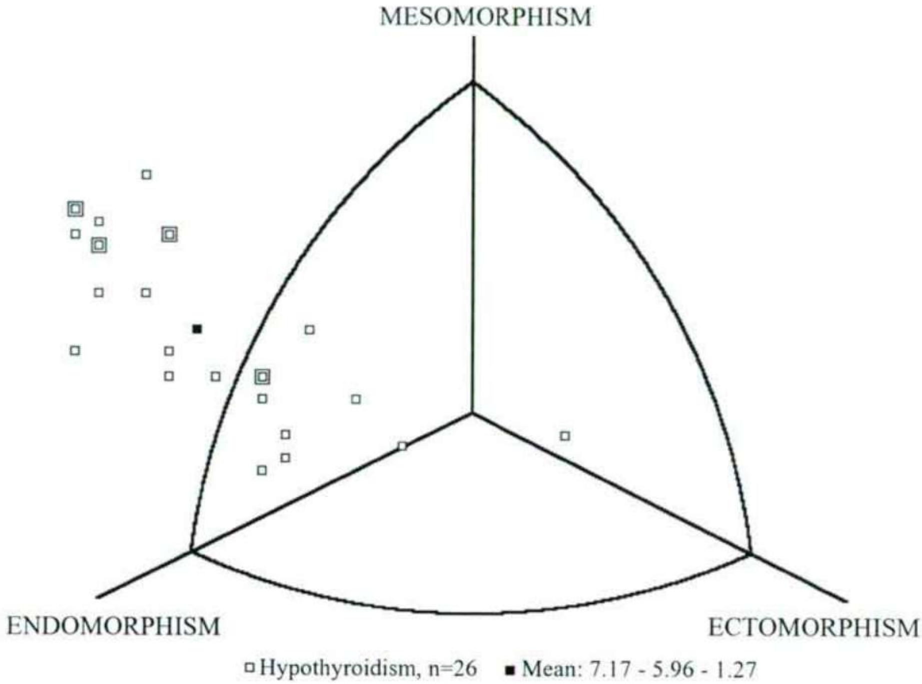

Fig. 2. Somatotypes of hypothyroid patients.

Conclusions

This study on hypothyroid and hyperthyroid patients revealed that the physique characteristics described by BUDAY (1943) can no longer be seen in the patients followed up, due to modern hormone therapy. The changes in physique of diagnostic value, summarized by MAGYAR and PETRÁNYI (1986), may develop in a patient with a recently diagnosed disorder; nevertheless, they markedly decrease later as a result of adequate therapy.

References

BUDAY, L. (1943): Orvosi alkattan. - A Magyar Orvosi Könyvkiadó Társulat kiadása, Budapest.
CURTIUS, F. (1954): Klinische Konstitutionslehre. - Spinger Verlag, Berlin-Göttingen-Heidelberg.
EIBEN, O. (1972): A morfológiai alkat variációi. - (DSc thesis) Budapest.
EIBEN, O. (1992): Alkalmazott alkattan. - ELTE Embertani Tanszék, Budapest, (manuscript).

HEATH, B. H. and CARTER, J. E. L. (1967): A Modified Somatotype Method. - Amer. J. Phys. Anthrop. *27*. 57-74.

MAGYAR, I. and PETRÁNYI, Gy. (1986): A belgyógyászat alapvonalai, I. - Medicina Könyvkiadó, Budapest.

MARTIN, R. and SALLER, K. (1957): Lehrbuch der Anthropologie, I. - Fischer Verlag, Stuttgart.

PADOS, GY., DETKI, K., JÁMBOR, Z., EIBEN, O., ZSINKA, Á. and DWORSCHÁK, E. (1988): Az elhízás két típusa, az alma és körte típusú elhízás és a lipid paraméterek. In: BIRO, GY. and BARNA, M. (eds): Nemzeti táplálkozási politika. - A Magyar Táplálkozástudományi Társaság XV. Vándorgyűlése, Bükfürdő, 40-42 pp.

ROSS, W. D. and WILSON, N. C. (1974): A stratagem for Proportional Growth Assesment. In: Borms, J. Hebbelinck, M. (eds): Children and Exercise. - Acta pediatrica Belgica, Suppl., 169-182 pp.

SHELDON, W. H., STEVENS, S. S. and TUCKER, W. B. (1940): The varieties of Human Physique. - Harper Brothers, New York-London.

TANNER, J. M., HIERNAUX, J. and JARMAN, S. (1969): Growth and Physique Studies. In: WEINER, J. S. and LOURIE, J. A. (eds): Human Biology. A guide to Field Methods. IBP Handbook No. *9*, - Blackwell Sci. Publ., Oxford-Edinbourgh, 76 pp.

TÓTH, G. (1996): A szomatometriai vizsgálatok és a klinikai alkattan jelentőségéről. In: GŐBL, G., KISS, B., LENDVAI, R., PUSKÁS, T. and SZEGECZKY, D. (eds): A Magyar Mentésügyi Tudományos Társaság VII. Vándorgyűlése, 1994. április 7-9., Szombathely. 115 p.

ACTA BIOL. SZEGED. 42, pp. 333-339 (1997)

STUDIES ON THE VARIABILITY OF GENETIC MARKERS IN THE BODROGKÖZ AREA, NORTH-EAST HUNGARY

H. WALTER

Department of Human Biology, University of Bremen, D-28334 Bremen, Germany

(Received: December 10, 1996)

Abstract

The main results of a population genetic investigation in the Bodrogköz area (North-east Hungary) are reported. Due to geographical factors, the population of this area was divided for a long time into a number of subpopulations, among which only restricted gene flow could take place. This could be proved by the sociodemographic analysis of parish registers, which are available since 1748. The allele and haplotype frequencies, respectively, of ten polymorphic blood group and serum group systems could be analyzed in a total of 1324 individuals from 15 villages of the Bodrogköz area. The variability of all these frequencies is considerable. The reasons for this are seen to reside in the fact, that due to the restricted gene flow within the Bodrogköz area, the results of locally acting genetic differentiation processes could be preserved up to the present time. This demonstrates the importance of the geographical isolation of human populations even in small, limited areas as an important factor for genetic differentiation, and thus for the understanding of microevolutionary processes in man.

Key words: Bodrogköz area (North-east Hungary), geographical isolation, variability of genetic markers.

Introduction

In 1965 and 1966, JÁNOS NEMESKÉRI (1914-1989) and myself analyzed the regional variability of various genetic markers of the blood in the Bodrogköz area, North-east Hungary. This area was selected for our studies for the following reasons: Until the beginning of this century, the Bodrogköz area, located in the north-eastern part of Hungary between the rivers Bodrog and Tisza, was a rather swampy area and the present villages were islands. Contacts between the populations of these islands were difficult and only possible by boat. These conditions resulted without doubt in a more or less strong limitation of marriages between the members of these geographically isolated populations, and thus also in restricted gene flow within this area. A considerable genetic heterogeneity could therefore be expected within the entire Bodrogköz population.

For several reasons, only parts of the results of this study have so far been published (WALTER et al., 1965; NEMESKÉRI and WALTER, 1966; WALTER and NEMESKÉRI, 1967, 1969, 1972; WALTER et al., 1968). In the following, the whole set of gene frequencies obtained in this study will be reported for the first time and briefly discussed. A detailed statistical analysis of the Bodrogköz data, which will also consider the results of the extensive population genetic studies in other regions of Hungary, conducted by CZEIZEL et al. (1991), is in progress and will be published elsewhere.

Materials and methods

In 1965 and 1966, blood samples were taken from a total of 1324 male and female individuals living in 15 different Bodrogköz villages, namely Bodroghalom, Cigánd, Dámóc, Karcsa, Karos, Kenézlö, Kisrozvágy, Láca-Cséke, Nagyrozvágy, Pácin, Révleányvár, Ricse, Semjén, Tiszakarád and Zemplénagárd. Figure 1 shows the locations of these villages in the Bodrogköz area. The blood group systems AB0, MNS, Rhesus, P, Kell and Duffy were typed in the laboratory of the hospital in Sátoraljaújhely. The sera of these individuals were decanted and transported to the Institute of Anthropology of the University of Mainz (I was working there at that time), where the serum protein groups HP, GC, GM and KM were tested. For several reasons, it was not possible, however, to type all the individuals for all the polymorphic blood group and serum protein group systems under study.

Results and discussion

Tables 1-6 show the distributions of AB0, MNS, Rhesus, P, Kell, Duffy, HP, GC, GM and KM allele and haplotype frequencies in the fifteen Bodrogköz subpopulations. It is apparent from these Tables that within the Bodrogköz area these frequencies are not distributed uniformly, but display more or less considerable distribution differences, thereby indicating a clear genetic heterogeneity within the entire population of this area. This heterogeneity can be explained by considering the population history of the Bodrogköz area.

According to historical sources, the settlement of the Bodrogköz area started about 1000 years ago. The first settlers of this area belonged among the Proto-Hungarian groups, who originated in the Middle Volga-Oka-Karma region, from where, from the end of the Bronze Period, they moved towards the west and reached the Don-Donets area between the 4th and 5th centuries. They mixed with Proto-Turkish elements. Between the 6th and 8th centuries A.D., the majority of these Proto-Hungarian groups moved further west and reached the Dniester-Dnieper area. In the 8th century A.D., the first waves arrived in the Carpathian Basin. In the 9th and 10th centuries A.D., most of these Proto-Hungarians came to the eastern regions of present-day Hungary, which includes the Bodrogköz area. A not inconsiderable proportion of these immigrants stayed here, and split up into many settlements on the islands present at that time. After this settlement, no significant further immigration took place into the Bodrogköz area, though of course some gene flow from outside cannot be excluded. Hence, the gene pool of the entire Bodrogköz population has not been affected significantly by secondary population movements. Due to the special geographical conditions of the Bodrogköz area, the various subpopulations remained more or less isolated from each other, even after the drainage of the Bodrogköz this century. A break up of this isolation has been observed to some extent since 1945, due to the changed sociological conditions in Hungary, and also due to the economic development of the Bodrogköz area.

Table 1. Distribution of A1A2B0 allele frequencies in the Bodrogköz area.

Population	n	*AB0*A1*	*AB0*A2*	*AB0*B*	*AB0*0*
Bodroghalom	77	0.246	0.064	0.156	0.534
Cigánd	162	0.234	0.067	0.121	0.578
Dámóc	101	0.213	0.044	0.160	0.583
Karcsa	133	0.235	0.079	0.215	0.471
Karos	26	0.266	0.083	0.039	0.612
Kenézlö	60	0.207	0.021	0.127	0.645
Kisrozvágy	51	0.321	0.075	0.079	0.525
Láca-Cséke	27	0.323	0.086	0.134	0.457
Nagyrozvágy	119	0.140	0.077	0.169	0.614
Pácin	160	0.222	0.093	0.124	0.561
Révleányvár	96	0.260	0.082	0.172	0.486
Ricse	84	0.276	0.052	0.183	0.489
Semjén	68	0.223	0.170	0.151	0.456
Tiszakarád	83	0.249	0.094	0.122	0.535
Zemplénagárd	77	0.267	0.076	0.128	0.529
Total	1324	0.234	0.076	0.146	0.544

Table 2. Distribution of MNSs haplotype frequencies in the Bodrogköz area.

Population	n	*MNS*MS*	*MNS*Ms*	*MNS*NS*	*MNS*Ns*
Bodroghalom	77	0.325	0.337	0.117	0.221
Cigánd	162	0.294	0.333	0.116	0.257
Dámóc	101	0.257	0.317	0.198	0.228
Karcsa	133	0.274	0.256	0.126	0.344
Karos	26	0.314	0.186	0.066	0.434
Kenézlö	60	0.241	0.318	0.052	0.389
Kisrozvagy	51	0.316	0.263	0.124	0.297
Láca-Cséke	27	0.250	0.324	0.102	0.324
Nagyrozvagy	119	0.208	0.356	0.131	0.305
Pácin	160	0.302	0.310	0.146	0.242
Révleányvár	96	0.173	0.410	0.077	0 340
Ricse	84	0.246	0.278	0.158	0.318
Semjén	68	0.294	0.243	0.042	0.421
Tiszakarád	83	0.209	0.400	0.096	0.295
Zemplénagárd	77	0.234	0.363	0.122	0.281
Total	1324	0.257	0.325	0.116	0.302

On the basis of parish registers, it was possible to examine the isolation of the Bodrogköz subpopulations from 1748 up to the present day, by analyzing the marriage connections between the various villages in this area. The results of these sociodemographic studies have been reported in detail by NEMESKÉRI and WALTER (1966) and WALTER and NEMESKÉRI (1972). It could be shown that between 1748 and 1779 most of the Bodrogköz subpopulations had no marriage contacts with one another. One can assume that such lack of contacts also existed in previous times and were probably even more marked. In the course of the 19th century, the intensity of marriage connections between the various Bodrogköz subpopulations increased somewhat. For Cigánd, for example, marriage data are available for 1600 persons for the period 1800-

1960. In 76.6% of all marriages, both partners came from Cigánd. In 12.8%, one partner came from another Bodrogköz village, especially from Tiszakarád (5.3%), Ricse (1.4%) and Pácin (0.7%). The names of the other Bodrogköz villages are not mentioned. However, it is to be seen from the parish registers that those partners were surely of Bodrogköz origin. In 10.6%, the marriage partner came from a non-Bodrogköz place. Similar results were obtained concerning the other Bodrogköz villages; for details, see NEMESKÉRI and WALTER (1966). In general, it can be stated that most of them were characterized by a relatively high degree of endogamy, which in villages like Tiszakarád, Cigánd, Ricse, Révleányvár, Zemplénagárd and Karcsa amounted to more than 50%. In the 20th century, the number of intervillage exogamous marriages has increased more and more, whilst the degree of endogamy has decreased accordingly. Though it can be supposed that within the Bodrogköz area the gene flow was more or less restricted for a long time, there is no indication for the assumption of a strong genetic isolation of the Bodrogköz subpopulations. In spite of the disadvantageous geographical conditions, therefore, the various subpopulations did not develop into true isolate populations, which were genetically completely isolated from each other.

Table 3. Distribution of Rhesus haplotype frequencies in the Bodrogköz area.

Population	n	*cd	*Cde	*cdE	*cDe	*Cde	*CDE	*cDE
Bodroghalom	77	0.494	0.041	0.000	0.000	0.348	0.000	0.117
Cigánd	162	0.416	0.108	0.000	0.016	0.256	0.015	0.189
Dámóc	101	0.479	0.001	0.010	0.011	0.356	0.000	0.083
Karcsa	133	0.409	0.060	0.000	0.021	0.346	0.018	0.146
Karos	25	0.265	0.000	0.000	0.000	0.560	0.000	0.175
Kenézlö	60	0.388	0.024	0.021	0.045	0.393	0.015	0.114
Kisrozvágy	50	0.435	0.041	0.000	0.019	0.330	0.000	0.175
Láca-Cséke	27	0.416	0.000	0.000	0.000	0.444	0.000	0.140
Nagyrozvágy	119	0.327	0.026	0.026	0.023	0.414	0.009	0.175
Pácin	160	0.356	0.001	0.010	0.010	0.481	0.000	0.142
Révleányvár	96	0.464	0.012	0.000	0.000	0.426	0.000	0.098
Ricse	84	0.404	0.012	0.012	0.012	0.460	0.000	0.100
Semjén	68	0.443	0.033	0.000	0.000	0.431	0.000	0.093
Tiszakarád	83	0.286	0.090	0.000	0.076	0.398	0.000	0.150
Zemplénagárd	77	0.331	0.000	0.000	0.058	0.494	0.000	0.117
Total	1322	0.398	0.034	0.006	0.025	0.396	0.003	0.138

The geographical peculiarities of the Bodrogköz area led us to expect that within this area the distribution of gene frequencies would not be homogenous, but would display more or less marked differences between the various subpopulations living here. This expectation proved to be correct, as appears from the figures presented in Tables 1-6. Without going into details here, it can be pointed out that, as concerns the allele and haplotype frequencies of all ten polymorphic blood group and serum protein group systems under study, a considerable distribution inhomogeneity is to be observed within the Bodrogköz population, which is statistically highly significant. The reasons for this can be presumed to lie in the effects of locally acting genetic differentiation processes, which could be preserved because of the geographically caused restricted gene flow between the various Bodrogköz subpopulations.

Table 4. Distribution of P, Kell and Duffy allele frequencies in the Bodrogköz area.

Population	n	*P*P*	*P*p*	*n*	*KEL*K*	*KEL*k*	*n*	*FY*A*	*FY*B*
Bodroghalom	77	0.219	0.781	73	0.034	0.966	73	0.380	0.620
Cigánd	162	0.324	0.676	13	0.000	1.000	13	0.379	0.621
Dámoc	101	0.325	0.675	100	0.089	0.911	100	0.392	0.608
Karcsa	133	0.317	0.683	10	0.051	0.949	10	1.000	0.000
Karos	25	0.337	0.663	19	0.082	0.918	19	0.438	0.562
Kenézlö	60	0.305	0.695	60	0.025	0.975	60	0.317	0.683
Kisrozvágy	51	0.343	0.657	11	0.046	0.954	11	0.325	0.675
Láca-Cséke	27	0.392	0.608	24	0.021	0.979	24	0.293	0.707
Nagyrozvágy	119	0.413	0.587	7	0.000	1.000	7	0.244	0.756
Pácin	160	0.334	0.666	136	0.041	0.959	136	0.515	0.485
Révleányvár	96	0.229	0.771	95	0.099	0.901	95	0.343	0.657
Ricse	84	0.236	0.764	75	0.020	0.980	75	0.327	0.683
Semjén	68	0.293	0.707	57	0.063	0.937	57	0.351	0.649
Tiszakarád	83	0.440	0.560	79	0.026	0.974	79	0.374	0.626
Zemplénagárd	77	0.386	0.614	76	0.082	0.918	76	0.449	0.551
Total	1322	0.322	0.678	835	0.053	0.947	835	0.391	0.609

Table 5. Distribution of HP and GC allele frequencies in the Bodrogköz area.

Population	n	*HP*1*	*HP*2*	*n*	*GC*1*	*GC*2*
Bodroghalom	77	0.460	0.540	77	0.617	0.383
Cigánd	162	0.305	0.695	162	0.744	0.256
Dámóc	88	0.375	0.625	89	0.512	0.488
Karcsa	131	0.332	0.668	131	0.729	0.271
Karos	25	0.500	0.500	25	0.860	0.140
Kenézlö	60	0.342	0.658	60	0.734	0.266
Kisrozvágy	50	0.320	0.680	49	0.612	0.388
Láca-Cséke	25	0.400	0.600	25	0.800	0.200
Nagyrozvágy	118	0.355	0.645	118	0.674	0.326
Pácin	158	0.351	0.649	157	0.761	0.239
Révleányvár	96	0.396	0.604	83	0.558	0.442
Ricse	83	0.313	0.687	83	0.585	0.415
Semjén	67	0.305	0.695	67	0.702	0.298
Tiszakarád	83	0.361	0.639	81	0.612	0.388
Zemplénagárd	76	0.480	0.520	75	0.673	0.327
Total	1299	0.361	0.639	1294	0.674	0.326

Of particular interest is the distribution of GM alleles in the Bodrogköz subpopulations. With one exception, all of them are characterized by the presence of only three GM alleles, namely *GM*1*, *GM*1,2* and *GM*5*, which are distributed in different frequencies. In one of the Bodrogköz subpopulations, however, in Pácin, it was not possible to explain the five observed GM phenotype frequencies GM (1,2,5), GM (1,-2,5), GM (1,2-5), GM (1,-2,-5) and GM (-1,-2,5) by assuming the three GM alleles mentioned above, but only by assumption of an additional allele: *GM*1,5*. This allele is quite uncommon among Europoid populations, but rather frequent among Mongoloids. To explain the existence of this GM allele in the Pácin subpopulation, two hypotheses are presented: 1) The *GM*1,5* allele was brought by the settlers and could be traced to a Mongoloid admixture. This is probable, if one takes into consideration the geographical origin of the Bodrogköz population. Due to the restricted marriage relationships of the Pácin subpopulation with other Bodrogköz subpopulations this allele could not diffuse and thus it would have been limited to the Pácin subpopulation. 2) The *GM*1,5* allele came into existence after the settlement, possibly through mutation or crossing-over. Unfortunately, at the time of our Bodrogköz study it was not possible to type the whole set of the 18 different GM allotypes, so that further and more detailed statements concerning this striking observation are not possible.

Table 6. Distribution of GM and KM allele frequencies in the Bodrogköz area.

Population	n	*GM*1*	*GM*1,2*	*GM*1,5*	*GM*5*	n	*KM*1*
Bodroghalom	71	0.154	0.043	0.000	0.803	72	0.072
Cigánd	162	0.155	0.077	0.000	0.768	162	0.097
Dámóc	72	0.118	0.028	0.000	0.854	79	0.045
Karcsa	129	0.143	0.012	0.000	0.845	129	0.068
Karos	24	0.041	0.042	0.000	0.917	24	0.087
Kenézlö	56	0.122	0.155	0.000	0.723	56	0.036
Kisrozvágy	49	0.244	0.041	0.000	0.715	50	0.083
Láca-Cséke	21	0.095	0.000	0.000	0.905	21	0.049
Nagyrozvágy	16	0.173	0.035	0.000	0.792	117	0.062
Pácin	136	0.071	0.101	0.095	0.733	145	0.083
Révleányvár	81	0.135	0.013	0.000	0.852	88	0.035
Ricse	75	0.205	0.048	0.000	0.747	77	0.067
Semjén	60	0.142	0.008	0.000	0.850	64	0.048
Tiszakarád	76	0.138	0.040	0.000	0.822	77	0.074
Zemplénagárd	66	0.158	0.062	0.000	0.780	68	0.045
Total	1194	0.143	0.051	0.011	0.795	1229	0.067

Though the genetic heterogeneity within the Bodrogköz area is evident, it is worth mentioning that the allele and haplotype frequencies, are not distributed randomly, but the genetic distances between the various subpopulations are clearly related to their geographical distances from each other (WALTER and NEMESKÉRI, 1972). Some examples will illustrate this. As concerns Semjén and the other 14 Bodrogköz villages, the rank correlation coefficient (τ) between genetic distances and geographic distances amounts to $\tau = +0.40$ ($0.20>p>0.10$), for Ricse and the other places, $\tau = +0.35$ ($0.30>p>0.20$), and between Révleányvár and the other places, $\tau = +0.52$ ($0.10>p>0.05$). This means that the smaller the geographical distance between two Bodrogköz villages, the smaller is the genetic distance between the respective subpopulations. It can be concluded from these observations that the genetic distances between the various Bodrogköz subpopulations are obviously correlated with the geographical distances between them.

To sum up, it can be pointed out that the distribution of genetic markers within the population of the Bodrogköz area is not homogeneous, but shows an obvious heterogeneity. The reason for this can be seen in a long-standing restriction of an unhindered gene flow within this area, caused by the specific geographic conditions of the Bodrogköz area. This resulted in restricted marriage contacts between the different Bodrogköz subpopulations and prevented a complete genetic intermixture of the entire Bodrogköz population. Hence, the local differences observed in the distribution patterns of the genetic markers under study, caused by locally acting genetic differentiation factors, could be preserved up to the present time. However, the allele and haplotype frequencies are not distributed randomly in the Bodrogköz area. The genetic distances between the various subpopulations are clearly positively correlated with the geographical distances between them. This means that in general the genetic distances between the various Bodrogköz subpopulations are the smaller, the smaller the geographic distances between them. Altogether, Bodrogköz proved to be a good example for the understanding of genetic differentiation processes even in small, limited geographical regions, and thus for the understanding of microevolution in man.

References

CZEIZEL, A., BENKMANN, H-G. and GOEDDE, H. W. (1991): Genetics of the Hungarian population. Ethnic Aspects, Genetic Markers, Ecogenetics and Disease Spectrum. - Springer-Verlag, Berlin-Heidelberg-New York.

NEMESKÉRI, J. and WALTER, H. (1966): Demográfiai és populációgenetikai kutatások Bodrogközben. - Demográfia *9*, 336-365.

WALTER, H. and NEMESKÉRI, J. (1967): Demographical and sero-genetical studies on the population of Bodrogköz (NE Hungary). - Hum. Biol. *39*, 224-240.

WALTER, H. and NEMESKÉRI, J. (1969): Populationsgenetische Untersuchungen im Bodrogköz (NO-Ungarn). - Wiss. Z. Humboldt-Universität zu Berlin, Math.-Nat. R. XVIII, 885-891.

WALTER, H. and NEMESKÉRI, J. (1972): Population genetic investigations in the Bodrogköz area of NE-Hungary. In: TÖRÖ, I., SZABADY, E., NEMESKÉRI, J. and EIBEN, O. G. (eds): Advances in the Biology of Human Populations. - Akadémiai Kiadó, Budapest, 329-343.

WALTER, H., NEUMANN, S. and NEMESKÉRI, J. (1965): Populationsgenetische Untersuchungen über die Verteilung von Hämoglobin S und Glucose-6-Phosphat-Dehydrogenasemangel im Bodrogköz (Nordostungarn). - Hum. Genet. *1*, 651-657.

WALTER, H., NEUMANN, S. and NEMESKÉRI, J. (1968): Investigations on the occurrence of glucose-6-phosphate-dehydrogenase deficiency in Hungary. - Acta Genet. (Basel) *18*, 1-11.

ACTA BIOL. SZEGED. 42, pp. 341-348 (1997)

ENVIRONMENT, PREGNANCY DURATION AND BODY MASS OF NEWBORNS

E. WÓJTOWICZ and J. GŁADYKOWSKA-RZECZYCKA

Department of Anatomy and Anthropology, Jędrzej Śniadecki University School of Physical Education, Wiejska 1 str., 80-336 Gdańsk, Poland

(Received: December 10, 1996)

Abstract

The relation was studied between the environment and the morphological conditions of 1796 newborns born in 1993-94. Two groups from areas of ecological risk and one from an ecologically "clean" area were investigated. Both the pregnancy duration and the body mass of the newborns proved to be decisively correlated with the state of the environment.

Key words: evironment, pregnancy duration, body mass of newborns, Gdynia, Kościerzy, Puck

Introduction

The recent progress in industrialization, urbanization and tourism in the province of Gdańsk has provoked a number of unfavourable changes in the atmosphere, the water resources, the soil and the flora together with a deterioration in the state of health of living organisms. The alarming conditions of the natural environment in Poland triggered an administrative step in March 1983 when 27 areas, currently inhabited by over one-third of the population of Poland, were declared to be at ecological risk (Tabs 1 and 2). Gdańsk province and some parts of the Elbląg region are such ecologically threatened areas, generally characterized by the following factors: 1) the loss of the natural balance in the environment, 2) a higher incidence of diseases due to environment degradation, 3) an increase in mortality in the population aged 40-59, and 4) high birthrate of newborns with low body mass (below 2500 g).

As indicated in numerous studies, the rate of morphological development and the state of health of the newborn population from an ecologically threatened area are considerably poorer as compared with the relevant values for populations from ecologically clean areas (ANDRYSZEK, 1993; ANDRYSZEK and DZIANKOWSKA, 1993; ANDRYSZEK et al., 1993; ROLEWICZ, 1993; SZUKALSKI, 1991; WÓJTOWICZ, 1996a,b,c). In view of the catastrophic condition of the natural environment in Poland, an attempt has been made to determine the factor that most decisively influences the pregnancy duration and the body mass in two populations of newborns in environmentally different regions in Gdańsk province: the environmentally "clean" region of Kościerzyna, and the environmentally endangered regions of Puck and Gdynia.

Table 1. Regions of ecological risk

Area	Risk coefficient
1.Górnośląski	194291
2.Krakowski	33894
3.Szczeciński	8464
4.Łódzki	7767
5.Rybnicki	6930
6.Gdański	6634
7.Legnicko-głogowski	5972
8.Tarnobrzeski	4637
9.Bydgosko-toruński	3862
10.Wrocławski	3287
11.Opolski	2910
12.Poznański	2188
13.Koniński	1844
14.Tarnowski	1275
15.Częstochowski	1274
16.Turoszowski	1204
17.Wałbrzyski	763
18.Białe Zagłębie	705
19.Inowrocławski	610
20.Płocki	599
21.Puławski	318
22.Chełmski	312
23.Włocławski	289
24.Bełchatowski	247
25.Myszkowsko-zawierciański	192
26.Jeleniogórski	185
27.Tomaszowski	171

Table 2. Gdańsk ecological risk region

ELBLĄG PROVINCE	
City Braniewo, Elbląg, Frombork, Tolkmicko	Community Braniewo, Elbląg, Frombork, Milejewo, Stegna, Sztutowo, Tolkmicko,
GDAŃSK PROVINCE	
City Gdańsk, Gdynia, Hel, Jastarnia, Pruszcz Gdański, Puck, Reda, Rumia, Sopot, Wejherowo, Władysławowo	Community Cedry Wielkie, Kolbudy Górne, Kosakowo, Krokowa, Pruszcz Gdański, Puck, Wejherowo, Żukowo

Materials and method

A group of 1796 newborns was investigated as concerns body mass and the duration of pregnancy. The revelant data came from questionnaires circulated in the years 1993-94 in Gdańsk province hospitals (Gdynia, Puck and Kościerzyna). The means and the standard deviations were calculated; the statistical significance of differences was verified with the test of two means (GREŃ, 1972). The data on the state of the environment were obtained from the Office of Statistics in Gdańsk and from the Polish National Office of Statistics. The material in the paper comprises only part of our data on 6000 newborns from all hospitals in Gdańsk province, which will be analysed progressively.

Results and discussion

The condition of the environment is commonly seen to be a vital factor as concerns the economies of invidual countries worldwide, Poland included, and studies on the population of newborns, whose state of health is undoubtadely linked with environmental hazards, are important and well-founded.

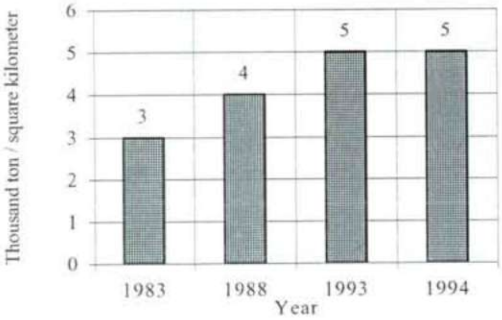

Fig. 1. Industrial pollution in Gdańsk province in 1983-94.

Genetic material undergoes modifications triggered by environmental factors; the directions such changes take depend on the condition of the environment.

Analysis of the data obtained from the Gdańsk Office of Statistics and the Polish National Office of Statistics and of our data on 1796 newborns (the duration of pregnancy and body mass) revealed the following about the environmental hazards in the region:

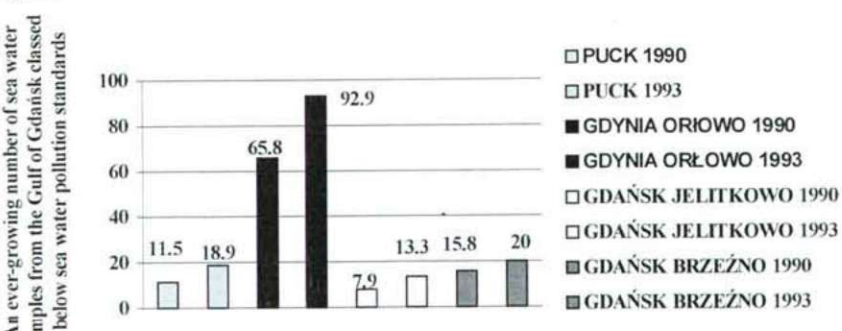

Fig. 2. Number of seawater samples from the Gulf of Gdańsk classified as below seawater pollution standard.

1. An increase in the industrial pollution of the local environment in the years 1983-94 (Fig.1).

2. An ever-growing number of seawater samples from the Gulf of Gdańsk classified as being below seawater pollution standards (Fig. 2).

3. A persistently high consumption of underground water resources in the region (60% locally vs. 15% countrywide), particularly by industry.

4. An insufficient number of sewage plants in the region (Fig. 3).

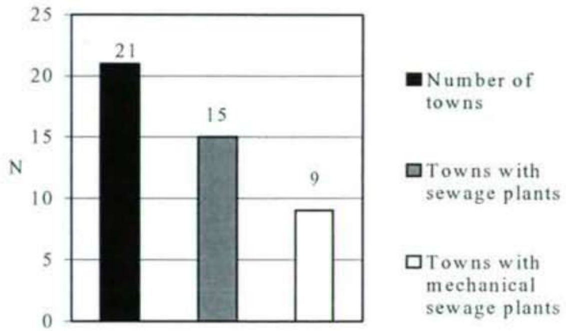

Fig. 3. Sewage plants in Gdańsk province in 1993.

5. An increase in carbon monoxide emission in the region (Fig. 4).

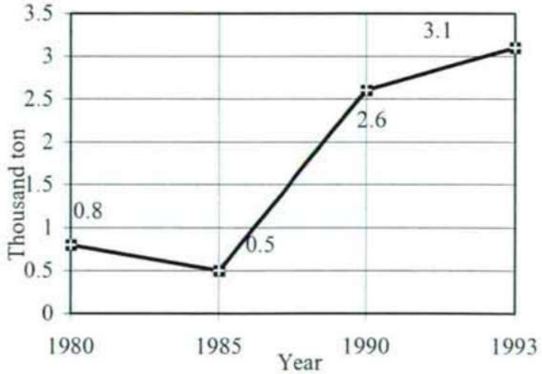

Fig. 4. Carbon monoxide emission in Gdańsk province in 1980-93.

6. Insufficient neutralization (below 1%) of gaseous pollutants comprising sulphur dioxide, nitrogen oxides and carbon monoxide (Fig. 5).

7. An alarmingly high and persistent level of carbon monoxide in the air (Fig. 4).

Carbon monoxide is a cigarette smoke component and one of the many agents responsible for the decreased oxygen level in the cells of the mother and the fetus cells. The decreased oxygen level in cells leads to an increase in the fetal carboxyhemoglobin level, which in turn reduces the potential of the blood both to carry oxygen around the body and to transfer it to the fetal tissues. Additionally, carbon monoxide reacts with cytochrome oxidase to aggrevate the intracellular oxygen deficiency and to affect adversely the biological condition of the fetus (BIENKIEWICZ, 1986; KOWALSKI, 1994; KUBICKI, 1991; Statistical Annals of Gdańsk province 1984, 1989, 1994; Sattistical reports - environment protection in Gdańsk province, 1994).

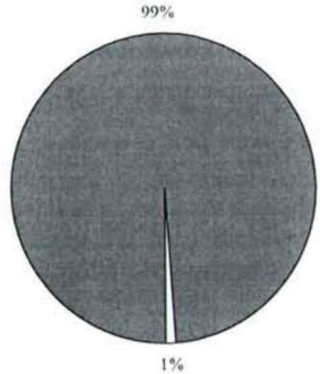

Fig. 5. Neutralization of gaseous pollution in Gdańsk province in 1993. 1%-Neutralization (below 1%) of gaseous pollutants comprising sulfur dioxide, nitric oxides and carbon monoxide.

8. In ecologically clean areas, the duration of pregnancy does not differ significantly between newborns of non-smoking parents and newborns of parents who smoke. However, it is statistically significant in environmentally endangered areas (d=0.001), and appears to be longer by nine-tenths of a week for the newborns of non-smoking parents (Fig. 9).

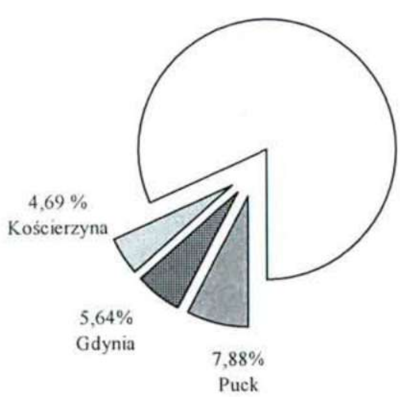

Fig. 6. Newborns with body mass below 2500 g in 1993-94.

9. In the areas of ecological risk (Gdynia and Puck), there are more newborns of low body mass (below 2500 g) than in ecologically "clean" areas; for the regions of Gdynia and Puck, this difference is about 1% and 3%, respectively (Fig. 6).

10. The most significant differences in pregnancy duration and body mass are manifested in springtime (21.03-21.06). Babies born in ecologically "clean" areas then have a body mass higher by approximately 187 g, which is a statistically significant difference at the level of d=0.01. Additionally, newborns from ecologically endangered areas are delivered about half a week earlier (d=0.02) than the normal term in ecologically healthy areas (Figs 7 and 8).

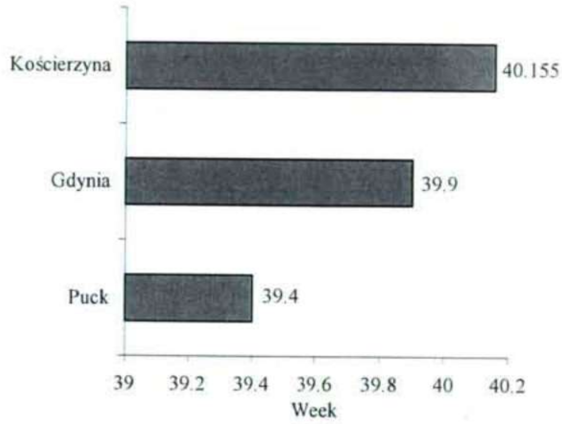

Fig. 7. Duration of pregnancy in springtime in 1993-94.

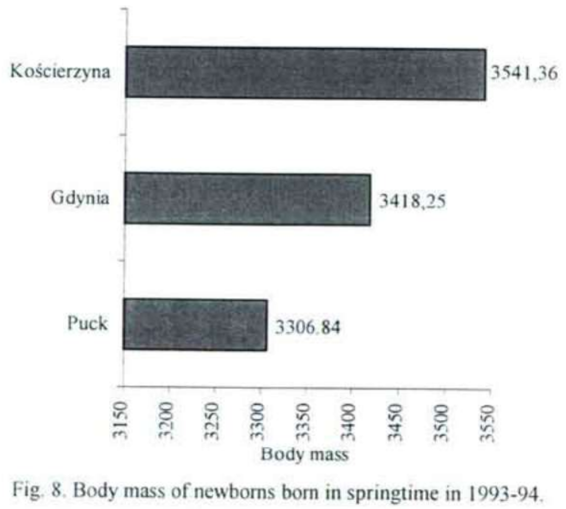

Fig. 8. Body mass of newborns born in springtime in 1993-94.

11. In springtime, the duration of pregnancy and the body mass of babies born to smoking parents in ecologically endangered areas generally appear below the norm.

The above results underline the fact that studies on the morphological condition of newborns as a function of the state of the environment are vital, and should model modern strategies towards our environment.

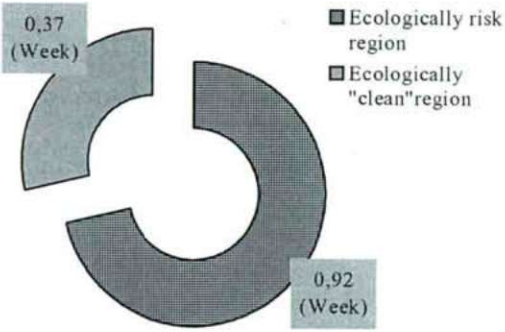

Fig. 9. Difference in duration of pregnancy between newborns of non-smoking parents and newborns of parents who smoke in 1993-94.

Conclusions

1796 newborns born in the years 1993-94 in three Gdańsk province hospitals (Gdynia, Puck and Kościerzyna) were investigated. The data on the state of the environment were obtained from the Office of Statistics in Gdańsk and from the Polish National Office of Statistics. The results show 1) an increase in the environment degradation, 2) in the areas of ecological risk (Gdynia and Puck), there were more newborns of low body mass (below 2500g) than in the ecologically clean area, and 3) the most significant differences in pregnancy duration and body mass are manifested in springtime.

References

ANDRYSZEK, CZ. (1993): Comprehensive evaluation of population health in provinces comprising high ecological risk areas as compared with so-called "ecologically clean" provinces. - Zdrowie Publ. *104*, 101-106, (in Polish).

ANDRYSZEK, CZ. and DZIANKOWSKA, E. (1993): Comprehensive assessment of the demographic situation of the population living in provinces of ecological danger as compare with "ecologically clean" provinces. - Zdrowie Publ. *104*, 193-196 (in Polish).

ANDRYSZEK, CZ., KOŃCZALIK, J., DUTKIEWICZ, T. and RACHAŃSKI, D. (1993): Premature mortality in areas of ecological risk (AER) in comparison with that in ecologically clean areas. - Zdrowie Publ. *105*, 57-67 (in Polish).

BIEŃKIEWICZ, L. (1986): Parental smoking and the state of health of the newborn. - Przegl. Pediatr. *16*, 1 (in Polish).

GREŃ, J. (1972): Models and tasks in mathematical statistics. - Warsaw (in Polish).

KOWALSKI, I. M. (1994): Influence of smoking on fetus birth weight and development of the newborn. - Zdrowie Publ. *105*, 89-90 (in Polish).

KUBICKI, J. (1991): Effect of smoking on fetal condition. - Gin. Pol. *62*, 489-491 (in Polish).

ROLEWICZ, CZ. (1993): Changes to the natural environment in the ecological risk areas in the years 1982-1988-1990. - Warsaw (in Polish).

Statistical Annal of Gdańsk province (1984). - Gdańsk Office of Statistics (in Polish).

Statistical Annal of Gdańsk province (1989). - Gdańsk Office of Statistics (in Polish).

Statistical Annal of Gdańsk province (1994). - Gdańsk Office of Statistics (in Polish).

Statistical reports - environment protection in Gdańsk province (1994). - Gdańsk Office of Statistics (in Polish).

SZUKALSKI, J.(1991): Changes to natural environment of Gdańsk due to man. - Jantarowe Szlaki *1*, 7-12 (in Polish).

WILKOX, A. (1993): Birth weight and perinatal mortality: The effect of maternal smoking. - Am. J. Epidem. *137*, 1098-1104.

WÓJTOWICZ, E. (1996a):The birth weight of newborns from different environments. - Przegl. Antrop. (in print; in Polish).

WÓJTOWICZ, E. (1996b): Estimation of state of health of the populations from selected areas. Academic Press, Lublin (in print; in Polish).

WÓJTOWICZ, E. (1996c): Developmental disturbances caused by ecological conditions. - Folia Morpholog. (in print)

INDEX