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Sexing and Stature Estimation Criteria for Balkan Populations

ABSTRACT: Two standard measurements, maximum femur length and head diameter, were collected by International Criminal Tribunal (ICTY) anthropologists. Only Kosovans had both femur dimensions for both sexes. Antemortem stature data were available only for Kosovan and Croatian males. Despite these limitations, the data offer the opportunity to examine ethnic variation and to present sex and stature estimation criteria for these groups. Additional data from Croatians and from American Whites were used for comparison in certain parts of the analysis. Femur variation was considerable. Kosovans can be characterized as short and robust, Bosnians as tall and less robust, and Croatians are tall and gracile, resembling American Whites more than the other groups. Some limited antemortem data on stature was also available, allowing stature estimation equations to be estimated for Croatians and Kosovans. Antemortem stature estimates were obtained from interviews with relatives and are shown to overestimate actual stature. We argue that equations predicting height obtained from relatives is the most realistic in this case because that is the height to which an estimate obtained from bone lengths will be compared. Kosovans were also shown to have experienced slight secular increase in femur length over the past 70 years.

KEYWORDS: forensic science, Balkans, stature estimation, sex estimation

Appropriate criteria are critical in developing the age, sex, race, and stature profiles that form the beginning point of a successful identification. Such criteria exist for American Whites and Blacks, and are routinely applied by American forensic anthropologists working on American cases (2). Adequate criteria obtained from contemporary populations are rare in other parts of the world, particularly those most in need of them where genocide, ethnic cleansing, and other such actions have kept forensic anthropologists engaged in various parts of the world. Komar (3) has shown the need for local standards in the Balkans where there is at least a beginning for understanding Balkans skeletal biology. Sexing criteria for the femur in Croatia have recently been presented (1). Several papers have dealt with stature in various ways (4–6). This paper will focus on postcranial skeletal data obtained by the International Criminal Tribunal (ICTY) from Kosovo, Bosnia-Herzegovina (BiH), and Croatia with the goal of providing sex and stature criteria specific to these populations. It will examine variation among these populations and their differences in relation to American sex and stature criteria. It will also examine the problems encountered with absence of good antemortem information concerning stature.

Materials and Methods

Metric data were obtained by ICTY anthropologists working in Croatia (1996), Kosovo (2000), and BiH (2001). The Croatian data consists of male individuals from the mass grave site in Ovcara, Croatia exhumed by the ICTY in 1996. The evidence was submitted to Court in *The Prosecutor vs. M. Dokmanovic* (IT-95-13a). Antemortem information for Kosovo was completed during the year 2000

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by the Transcultural Psychosocial Organisation (TPO) as part of a joint effort to identify the victims of the conflict that besieged Province between 1998 and 1999. Stature data from all samples were collected as part of the antemortem information routinely collected from relatives of the victims in order to carry out identification.

Anthropologists working for the ICTY during those years collected skeletal metric data. Several long bones were measured, but the femur is the only one from which data were systematically collected, so analysis is limited to the femur. Variables are maximum femur length and maximum head diameter. These variables are standard and are defined in most measurement guides, such as described by Moore-Jansen et al. (7). For certain parts of the analysis, data reported by Slaus et al. (1) and data collected by Ross (8) were also used. Data from American Whites were available from the forensic anthropology data base (9). Sexing criteria will be examined using femur head dimensions and stature estimation will be examined using maximum femur length.

Linear and loess regression analyses were implemented using Axum, version 4 for Windows. Loess regression makes no assumptions about the form of the regression line, building a model by fitting simple models to localized subsets of the data (10).

Results

Femur Morphometry

Tables 1 and 2 present the summary statistics for the ICTY Balkans data and the American Whites from the Forensic Anthropology Data Bank. The samples exhibit highly significant variation for both femur length and femur head dimensions. Compared with American Whites, Kosovans have much shorter femora and larger heads, indicating shorter, more robust people. Bosnian males have the largest femur heads and lengths are somewhat greater than Kosovans. Croatian males have femur lengths comparable to American Whites, but lack femur head data.

Figure 1 presents a two-dimensional plot of femur length and femur head diameter, which provides an overall impression of femur size and shape variation. The data were first converted to

TABLE 1—Maximum femur lengths of Eastern European samples and American Whites.

Group	Males*			Females†		
	N	Mean	SD	N	Mean	SD
Kosovo	532	462.470	23.624	92	418.098	23.577
Croatia	85	475.424	23.007	—	—	—
Bosnia	31	469.871	20.379	—	—	—
American White	298	475.027	23.217	148	435.297	21.154

*F = 21.87; df = 3 and 942; p < 0.001.
 †F = 34.32; df = 1 and 238; p < 0.001.

TABLE 2—Maximum femur head diameters of Eastern European samples and American Whites.

Group	Males*			Females†		
	N	Mean	SD	N	Mean	SD
Kosovo	446	49.496	2.752	73	43.986	2.486
Bosnia	31	50.484	2.293	—	—	—
American White	303	48.670	2.935	147	42.170	2.258

*F = 11.10; df = 2 and 777; p < 0.001.
 †F = 29.48; df = 1 and 218; p < 0.001.

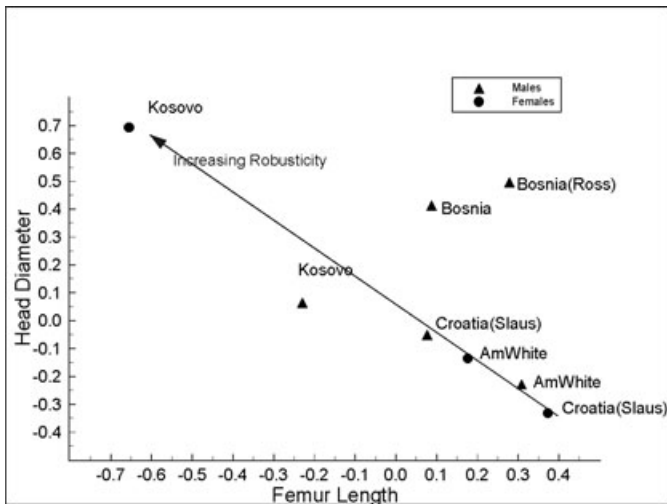


FIG. 1—Plot of femur head diameter on femur length for Bosnians, Croatians, Kosovans, and American Whites, showing variation in robusticity.

sex-specific z-scores in order to put femur length and head diameter onto a common scale, and to remove sex differences. In addition, the Croatian sample presented by (1) and the unpublished data of Ross (8) were included. The arrow points to increasing robusticity as one moves from lower right to upper left on the plot. The distribution shows Kosovans, with short femora and large head diameters to be robust, as opposed to the more gracile American Whites, with long femora and small heads. Kosovans, American Whites, and Croatians fall approximately on the line of increasing robusticity, as femur lengths decrease and head diameters increase. Both Bosnian samples show a pattern of long femora accompanied by large femur heads, yielding intermediate robusticity. A larger sex difference is observed among Kosovans than the other groups, identifying Kosovo females as the most robust of all samples analyzed.

TABLE 3—Sectioning points and sex classification rates for Kosovans and American Whites.

Group	Sectioning points	Males		Females	
		No. correct	% Correct	No. correct	% Correct
Kosovo	46.741	389/446	87.2	66/73	90.4
American White	45.420	271/303	89.4	134/147	91.2

Femur Head Sexing Criteria

Variation in femur head diameter shown in Table 2 has some obvious implications for sexing. Table 3 shows the group-specific sectioning points for Kosovans and American Whites. Femora with head diameters greater than the sectioning point are classed male, below as female. The two groups are comparable in correct classification rates, American Whites at about 90.0% and Kosovans slightly less. The sectioning point of Kosovans is over 1 mm greater than that for American Whites. If one applies the American White sectioning point to Kosovans, one gets 93.5% of Kosovo males correct, but only 72.6% of females. Because of the larger femur head diameter, too many Kosovo females are classified as males.

Secular Change and Antemortem Stature

There is sufficient data to investigate secular change in femur length in the Kosovo male sample. Figure 2 presents the fitted linear regression of femur length on year of birth and a loess regression line. Table 4 presents the linear regression statistics. The linear

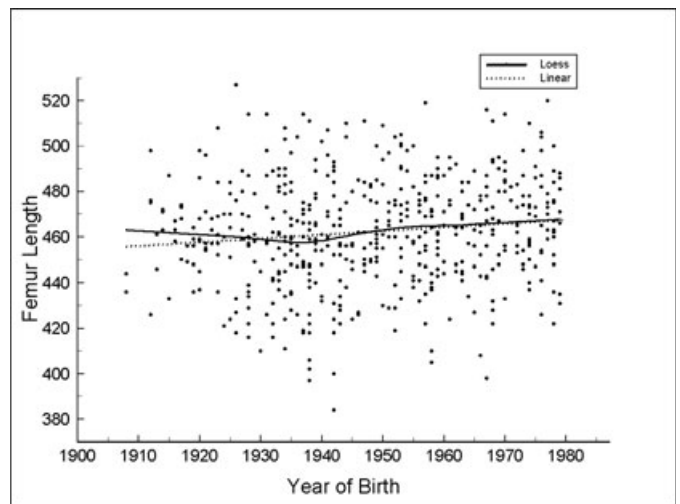


FIG. 2—Plot of femur length on year of birth in Kosovans. The linear regression and loess regression lines are shown. The two lines are identical after about 1945.

TABLE 4—Statistics for regression of femur length on year of birth for Kosovo males.

Parameter	Estimate	SE	t*	P-value
Year of birth	0.164296	0.057272	2.87	0.004
Constant	142.13	111.608	1.27	0.203
R ²	0.01341			

*df = 531.

regression model is highly significant. The loess line indicates a slight decrease in femur length in the early part of the century, followed by an increase after about 1940. The loess and linear regression lines are nearly identical after 1940. The results document an increase in femur length amounting to about 7 mm since 1940.

Stature Estimation

The principal problem in developing stature estimation formulae is lack of reliable antemortem height estimates. Estimates obtained from family members are likely subject to considerable error. Error can be random or systematic. One way to assess the systematic error is to compare the antemortem stature with that estimated from various regression equations. Table 5 presents this comparison for Croatians and Kosovans possessing both an antemortem stature and a femur length from which an estimate could be obtained. The estimated statures are all obtained from regression equations derived from populations of European ancestry (4,6,11,12) and all are in close agreement. They all provide estimates some 2–3 cm lower than reported antemortem stature, which can be taken as the overestimate of antemortem stature, unless the regression estimates are themselves biased.

Another method to assess antemortem stature estimates is to compare them to measured anthropometric survey data. We were able to locate stature information from Croatia (13), which presents heights of children between ages 7 and 19 measured in 1951, 1964, 1973, 1982, and 1991. We used the heights for 19 year olds, which translate into birth year cohorts from the 1932 through 1972.

TABLE 5—Reported antemortem height for males and estimated height from various stature estimation equations.

	Croatsians (n = 85)		Kosovans (n = 70)	
	Mean	SD	Mean	SD
Antemortem height	178.165	6.328	175.786	7.372
Ross & Konigsberg (4)	175.761	5.434	172.870	6.256
Sarajlic (6)	176.056	6.167	172.775	7.098
Trotter & Gleser (10)	174.561	5.476	171.648	6.303
Trotter & Gleser (11)	175.828	5.337	172.989	6.143

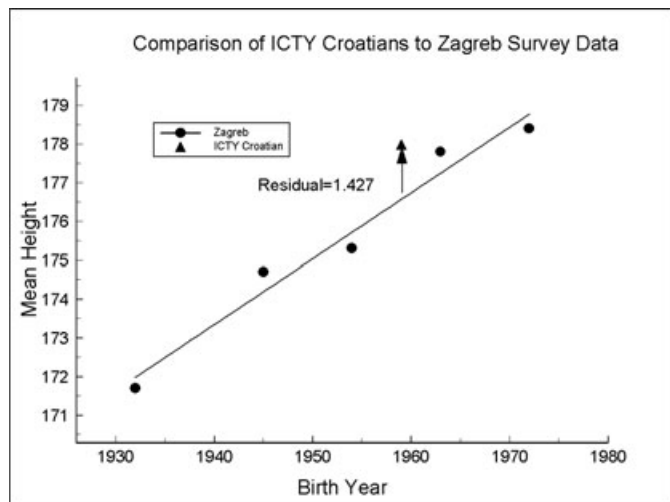


FIG. 3—Measured height on year of birth of 19-year-old Croatian males showing secular changes. Antemortem height estimates of Croatians show a positive deviation, which may be taken as an estimate of over reporting.

TABLE 6—Regression equations for stature estimation obtained from Croatian and Kosovo samples.

Parameter	Croatsians	Kosovans
N	85	70
Slope	0.2058 ± 0.0200	0.1576 ± 0.0253
Constant	80.3308 ± 9.5341	102.9870 ± 11.7222
Error of estimate (SSE)	4.224	5.543
R ²	0.5600	0.364

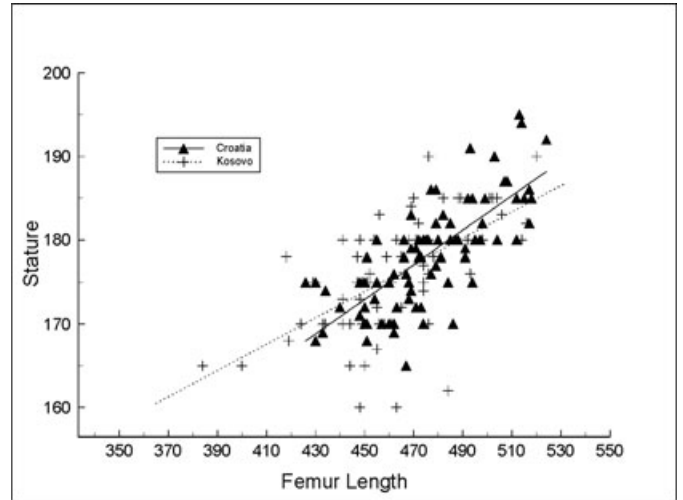


FIG. 4—Plot of stature on femur length with fitted regression lines for Croatians and Kosovans.

There is a clear secular trend in these data, as shown in Fig. 3. The Croatian antemortem sample is shown in Fig. 3 at its average birth year. Its deviation from the regression line is taken to be the overestimate of height. It suggests an overestimate of about 1.4 cm, slightly less than the estimate obtained from regression, but both methods indicate that antemortem stature is systematically overestimated in Croatians.

Table 6 presents the statistics for the regression of stature on femur length, and Fig. 4 shows the data points with fitted regression lines. Both groups have higher errors of estimate than is normally the case in measured stature, for example (11). The higher error of estimate results from a higher stature variance and a weaker relationship between stature and femur length than is normally found in measured stature. Kosovans have the higher error estimate and lower R². There are several points to be seen in Fig. 4 that could be termed outliers. We have chosen not to remove them from the analysis under the logic they likely represent errors in antemortem stature estimates and hence accurately represent the problems inherent in this kind of data.

Discussion

This paper has presented analyses of some basic metric data available from three populations of the former Yugoslavia, Croatians, Bosnians, and Kosovans. Ross (14) has shown considerable variation in cranio-facial morphology in the region, and our limited data on femur metrics and stature also point to heterogeneity. Femur metrics and stature show Kosovans to be shorter and more robust than Croatians and Bosnians, and Bosnians are more robust than Croatians.

Robusticity has several causes, chief among them are activity levels and climate (15). Research dealing with activity levels tends to focus on long bone shafts, which are subject to modification into adulthood (16). Our assessment of robusticity comes only from femur head, which is apparently not subject to modification once the adult condition is reached (16). Pearson (15) and Collier (17) present femur head robusticity indices (femur head diameter/femur length \times 100) for population samples representing different climates and economic strategies. Femur head robusticity values are 10.68 ± 0.54 , 10.49 ± 0.68 , and 10.71 ± 0.53 for Kosovo males, females, and Bosnian males, respectively. The Kosovans and Bosnians fall within the range of cold climate populations, although Kosovo females are at the upper end and hence quite robust by world standards. In present evidence, we are unable to attribute the robusticity of Kosovans and Bosnians to any particular cause.

The stature estimation results require some additional comment. We have observed that antemortem estimates, having been obtained primarily from interviewing relatives, are likely too large. Overestimation of stature from antemortem records has been shown to exist in Americans (18) and the large variation in different antemortem records has also been documented (19). Stature estimates of Kosovans or Croatians using the equations presented in this paper will in general be greater and have larger prediction intervals than those obtained from measured stature. Some may question whether such an outcome is desirable. Antemortem estimates such as those available in the present study are what Ousley (20) has called forensic stature. He has argued that forensic stature is precisely what we should be estimating because those are the antemortem records to which the estimate will be compared. The consequences of using measured stature estimates can readily be seen in Komar's (3) finding that only 29.4% of stature estimates from Srebrenica included the reported antemortem stature. Applying the stature equations presented here will be more likely to include the antemortem estimate and are therefore less likely to falsely exclude the actual victim.

This study also identified positive secular change in femur length in the Kosovo sample. What is surprising is that the amount of secular increase is approximately the same as that experienced by American Whites. In both groups, the increase amounts to about 10 mm from 1910 to 1970, as estimated from the linear regression in Table 1 and a similar regression from (21). The improvement in living conditions in America during the 20th century has been well documented. For Kosovo, historical quantitative measures of well-being, such as infant and childhood mortality and morbidity rates or quality and quantity of food resources are difficult to obtain. Limited available evidence points to suboptimal conditions not conducive to positive secular change. According to UNICEF, Kosovo has the worst child and maternal vital indicators in Europe (22). Historians of Kosovo speak of conditions of harsh poverty during the mid-20th century (23). Positive secular change has been observed in East Germans, who lag only slightly behind West Germans and both exceed Americans (24). Clearly secular change does not necessarily follow indicators of economic well-being. Our findings are one more indication that we do not fully understand what drives secular change.

The primary message contained in the analysis is that the populations of the former Yugoslavia require their own sexing and stature estimation criteria and that American criteria cannot be applied to them. Ethnic variation suggests that further population or ethnically specific criteria are required. In so far as possible with the limited data available, these have been provided. The limited

analyses highlight the desirability of systematically collecting skeletal information from local populations to increase reliability of estimations.

Disclaimer

This study does not represent in whole or in part the views of the United Nations but those of the authors.

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