The stature of some medieval Swedish populations
Werdelin, Lars
Fornvännen 80, 133-141
Ingår i: samla.raa.se
The stature of some medieval Swedish populations

By Lars Werdelin


The statures of four medieval populations (Löddeköpinge, Helgeandsholmen, Västerhus and Leksand) and one Neolithic population (Västerbiers) from Sweden are calculated and statistically analysed and compared. The female populations from Västerhus and Leksand are found to include some heterogeneity, and it is suggested that this may be due to social factors, particularly kinship structures, acting in these populations. The female population from Helgeandsholmen is found to be anomalously short in stature. Reasons for this are not clear, but are thought to be related to socioeconomic conditions peculiar to this population. The stature difference between males and females at Löddeköpinge is found to be small in comparison with the other medieval populations, and this is related to possible nutritional deprivation. There is no unequivocal evidence for a change in stature between the Neolithic and the Middle Ages. It is concluded that a thorough statistical analysis of statures can be highly revealing, and have important consequences, both in itself and for archaeological analyses of a population and its culture.

Lars Werdelin, Department of Geology, University of Stockholm, S-10691 Stockholm, Sweden.

Introduction

The stature of earlier populations and the estimation thereof has long been an important issue in physical anthropology (e.g. Wells 1963). It has, for example, been proposed that stature is related to nutritional status, so that populations with a highly nutritional diet will be relatively tall. This issue also relates to the general increase in stature of caucasian populations in Western Europe and North America, as reported by among others Aubenque (1957), Bryn and Schreiner (1929) and Bowles (1932). Unfortunately, many discussions of changes in stature, including those of recent populations, have been hampered by methodological problems, particularly concerning the estimation of stature from skeletal remains. This paper tries, by using uniform methodology throughout, to minimize these problems, and instead attempts to address some questions concerning the analysis of statures, both within and between populations.

The methodology of stature estimation, especially issues related to the statistical methods, is extensively reviewed by Sjøvold (1974), and only two points will be touched upon briefly here. First, there is still some confusion as to how the calculation of stature from regression equations should be carried out. Some recent authors, working from Holck’s (1970) recommendations, have made independent estimates of stature from several long bones, and then averaged these estimates. The regression equations used are, however, those of Trotter and Gleser (1952), who
specifically warn against using this method (see also Sjøvold 1974). Most authors, following Trotter and Gleser, instead recommend using that combination of long bones for which the regression equation has the smallest standard error. This method has been applied in the present paper, and statures of previously published populations recalculated. A second problem, which has been circumvented in the present study, is that stature estimates obtained from different regression equations are not directly comparable (cf. Kurth 1954). Here all calculations have used Trotter and Gleser’s (1952) equations, and if a future author wishes to compare his results with those presented here without having to redo all the calculations, this method must be used.

If methods of stature estimation have been much debated in the literature, the interpretation of the results obtained from them has been much less so. Most discussions of stature have been limited to comparing the stature of earlier populations with that of recent ones, or at best to longitudinal studies of stature changes with time (Wells 1963; Helmuth 1965). This is unfortunate for several reasons. In the first place, valuable information is lost by not considering the distribution of statures in the population under study. Secondly, making comparisons with recent populations is dangerous, since the statures in one case have been calculated and in the other measured directly, and also as the question of stature increase over the last century still is an open issue. Huber (1968, in a review of the literature on stature increase in recent populations) concludes: “...that maximum stature has increased recently, in populations of Northern European ancestry at least, is not presently justified by the available evidence...” (1968 p. 98).

Very few studies have concentrated on comparing roughly contemporaneous skeletal populations, an exercise which could afford valuable insights into these populations, as I hope to show below. Points which especially deserve attention are, besides the mean, also the variance, which can indicate if the samples analysed come from the same basic population or not, the skewness of the distribution, which will indicate biases or other anomalies in the material, the kurtosis of the distribution, which, among other things may, together with the variance and coefficient of variation, suggest whether the sample is homogeneous or not. For example, Broberg (1983) suggests that the human skeletal material from Helgeandsholmen in Stockholm is too heterogeneous, both temporally and socio-economically, to be of use for anthropological studies. However, if a sample includes several subsamples with different means, one would expect the resulting total distribution of statures to be platykurtic (relatively flat). As we shall see below, this is not the case for...
Helgeandsholmen, and we may therefore tentatively conclude that, in this one feature at least, the Helgeandsholmen material is homogeneous, however temporally and economically heterogeneous it may otherwise be. A final point to consider is the difference in mean stature between males and females in the same population. It has been suggested (e.g. Tobias 1970) that women are more resistant to nutritional deficits than are men, and that this will reflect on their relative statures. If this is so, one would expect the difference in stature between men and women in nutritionally deprived populations to be relatively small. The above list is certainly not exhaustive, and as more populations are analysed in this way, further interesting features will be found.

**Material and Methods**

The calculations carried out in the present paper are based on the following populations: Västerhus, Jämtland (Gejvall 1960), Löddeköpinge, Skåne (Persson & Persson 1983), Leksand, Dalarna (Sjovold 1982), and Helgeandsholmen, Stockholm (unpublished measurements by J. Sjöberg, deposited in Antikvarisk-Topografiska Arkivet, Stockholm). All of these populations are medieval. In addition, the material from the neolithic cemetery Västerbjer, Gotland (Stenberger et al. 1943; Sjovold 1974), was included in the comparisons, to see how the temporal factor would influence results. All populations are thus from Sweden (Fig. 1).

As mentioned above, the regression equations of Trotter and Gleser (1952) were used. For several reasons, these may be considered the best so far available (cf. Sjovold 1974). For the purposes of the present study, however, it is of little or no importance which regression equations are used, as long as the same set is used for all populations. It is only when comparisons with recent populations are to be made that the question of which equations to use becomes a major issue. Neither does it matter that different sets of equations are used for males and females, as long as the same pair of sets is used for each population.

Trotter and Gleser give regression equations for a large set of long bones. After having tested all of these on the same population, I have found that there is an indication, albeit not statistically significant, that equations for the long bones of the upper limb result in greater statures than those for the bones of the lower limb. It is thus possible that there has been a slight change in the relative proportions of the upper and lower limb since medieval times, and I have for that reason and to minimize possible error, used only the regression equations for the long bones of the lower limb, the femur and tibia. This has reduced the size of the available populations somewhat, but hopefully increased the reliability of the results. It should be pointed out that Huber (1968) also did not find any statistically significant difference in relative proportions of the upper and lower limb between Allemanns from the fifth to eighth century AD and the recent populations of Trotter and Gleser (1952, 1958).

There remains one possible major source of error, and that is that the skeletons of the five populations were measured by different people. This problem is particularly acute in the case of Västerbjer (see discussion in Sjovold 1974). Over this source of error I have unfortunately not had any control. It has not been feasible within the limits of the present study to remeasure all the material, nor even any single population.

The statistical methodology is for the most part such as can be found in any standard text on the subject (e.g. Sokal & Rohlf 1981). Basic statistics calculated are: $N =$ number of cases; $\bar{x} \pm 95 \% = $ mean and its 95 % confidence interval; $SD =$ standard deviation (for $N-1$ cases); $O. R. =$ observed range. In addition, the skewness, which in essence measures the relative location of the mode (negative skewness indicates that the mode is shifted to the right, positive that it is shifted to the left), and kurtosis, which measures how peaked or flat the curve is (a leptokurtic curve is relatively peaked and a platykurtic one relatively flat), were calculated for each population, and tested for significance. The homogeneity of the variances of the different populations

**Förmännen 80 (1985)**
was tested, and in the case of females it was found that they were not homogeneous. For the comparison of means, I have used the $G_2$-method (Sokal & Rohlf 1981) in the case of males. Since variances were heterogeneous in the case of female populations, I have used the approximate method of Games and Howell (Sokal & Rohlf 1981) to compare means. Finally, it should be pointed out that the $x^2$-tests of the sex distribution referred to below are based on the material for which stature could be estimated only, and not on the entire skeletal material of any site.

**Results**

The summary statistics for the five populations under consideration are shown in Table 1. As mentioned above, the variances of the female populations were heterogeneous, and an inspection of the standard deviations in Table 1 indicates that it is probably Västerhus which is anomalous. This population shows a much higher standard deviation in statures than either of the others. Furthermore, the observed range shows that this is probably due to a relative extention of the lower end of the size range. Thus, the tallest women in the Västerhus and Löddeköpinge populations are nearly equal in stature (171 and 174 cm, respectively), but the shortest woman in Västerhus is far shorter than in Löddeköpinge (141 against 149 cm). Possible reasons for this will be considered below.

The women from Västerhus, together with those from Leksand, are also anomalous in another respect. Both of these populations can be seen in Table 1 to be significantly negatively skewed, meaning that the mode of the distribution has been shifted toward the large end of the size range. In the case of Västerhus, this distribution, which if looked at in another way means that there is a relatively long tail of individuals of short stature, together with the relatively large variance, suggests that there is some heterogeneity present in this population. This indication is enhanced by the fact that Västerhus is the only population for which the variance for males is lower than for females (Table 1).

There are no similar anomalies in the populations of males shown in Table 1.

The results of the $G_2$-method and Games and Howell method for the comparison of means are shown in Table 2. For men there were significant differences in mean stature between Löddeköpinge and Västerhus, Helgeandsholmen and Västerhus (the former in each case being the shorter population), and Västerbjers and all populations except Löddeköpinge (with Västerbjers the shorter population in all cases). That Västerbjers should differ from the other populations is perhaps not surprising, given the temporal isolation of this population. It is more notable that Västerhus once again stands out as ex-
Table 2. Results of the GT2-method for men (left) and Games and Howell approximate method for women (right). * = significantly different at the 5% level. — = not statistically significant.

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Females</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Löddeköpinge</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Helgeandsholmen</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>*</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Västerhus</td>
<td>*</td>
<td>*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Leksand</td>
<td>—</td>
<td>—</td>
<td>*</td>
<td>*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Västerbjer</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 3. Difference in mean stature between men and women in the populations under study.

<table>
<thead>
<tr>
<th>Population</th>
<th>Difference (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Löddeköpinge</td>
<td>9.3 cm</td>
</tr>
<tr>
<td>Helgeandsholmen</td>
<td>14.7 cm</td>
</tr>
<tr>
<td>Västerhus</td>
<td>12.7 cm</td>
</tr>
<tr>
<td>Leksand</td>
<td>13.4 cm</td>
</tr>
<tr>
<td>Västerbjer</td>
<td>9.8 cm</td>
</tr>
</tbody>
</table>

ceptional. Both these points will be further considered below.

In the case of females (Table 2), significant differences were found between Helgeandsholmen and Löddeköpinge and Helgeandsholmen and Västerhus (Helgeandsholmen being shorter). Here, then, it is the Helgeandsholmen population which is exceptional in being so very short in mean stature.

The difference in stature between males and females in each of the five populations is shown in Table 3. The material clearly falls into two groups: one, including Västerhus, Leksand and Helgeandsholmen, displaying a relatively large difference in stature between the sexes, the other, including Löddeköpinge and Västerbjer, displaying a relatively small difference. This very interesting result will be discussed in relation to nutritional status in the following section.

Discussion

The results outlined above and in Tables 1–3 raise some interesting issues which require further consideration. In the text below, different explanations for these results will be considered, both in terms of physical and social anthropology.

In general, the possible explanations for a given set of facts concerning a skeletal population can be separated into two classes. They may be due to factors occurring prior to or during interment, or they may be due to factors occurring after interment.

Factors occurring before or during interment can, in turn, be separated into three categories. The first category concerns the genetic constitution of the population. Here we find explanations in terms of how closely related the individuals of the population are. Results of such relatedness which are of particular interest are inbreeding and genetic drift, both of which may influence skeletal remains. The second category concerns the effects of the physical environment on physique. There are factors in the environment, such as nutrition, which have a direct influence on the physical appearance of a population. The third category of preinterment factors concerns the social structure of the population. A simple example would be if the population under study is biased towards individuals from a certain social class. It is possible to further subdivide the above-mentioned categories, but for the present purposes this is not necessary. In actual cases, it is, of course, highly unlikely that an observed pattern can be explained by any one of the above categories alone, as they are deeply interwoven in each other. A hypothesized genetic differentiation is most likely to have been preceded by a social differentiation, environment in many
cases directly influences social structure, etc. The second basic class of factors, those occurring after interment, includes two categories: biases due to methods of excavation, and taphonomic (preservational) biases. The first of these factors can and should ideally be under the control of the investigator, though of course this is not always the case. The second has not been considered in much detail for non-fossiliferous human skeletal material but is clearly of major importance. If e.g. in a cemetery, skeletons buried near the church are better preserved than skeletons buried far from it, this may introduce major biases into the material. Huber (1968) found for his Allemanic population an apparently socially stratified bias in preservation, with skeletons buried with a heavy armament being less well preserved than skeletons buried with light armament, which in turn were less well preserved than skeletons buried without arms. An in-depth study of relative preservation of skeletons in a cemetery and its physical and chemical causes would thus be of great value. Without such detailed information, it is impossible to assess the preservational bias inherent in any material. In the absence of information to the contrary I have in the present study for the most part assumed that preservational biases are not of major importance to the discussion of the causes of the observed patterns.

Turning from these general considerations to their application in the present case, let us first consider Västerhus. Both variance, observed range and the observed significant negative skewness indicate that there is some heterogeneity present in this material. Although postinterment factors cannot be ruled out, the fact that both sexes are equally represented at Västerhus ($\chi^2 = 1.059, p > 0.05$), tends to corroborate the hypothesis that these are not the cause of the observed pattern. Is the pattern due to environmental effects? Probably not, as these would be likely to affect the population as a whole, and Västerhus, although somewhat anomalous, is not markedly different from the other populations under consideration.

It remains to consider social and genetic factors. The former have clearly played a role in determining the physical appearance of the cemetery. There was an almost total segregation of the sexes in the cemetery, with women being buried to the north of the church, and men to the south of it. In addition, there is some suggestion that taller individuals were buried closer to the church, and short individuals in the peripheral areas (Gejvall 1960 p. 77). This is, however, not generally true. The shortest woman, no. 36 in Gejvall’s (1960) system, was buried fairly close to the church (see plan of cemetery in Gejvall 1960). Thus, while the suggestion presents itself that socially high ranking individuals were buried closer to the church, the equation socially high ranking = tall is of questionable validity. Nonetheless, it is possible that social stratification may have influenced the results of the stature estimations. However, if this were the only explanation for the given facts, one would expect to see the same pattern in both sexes. The male population of Västerhus, except for being relatively tall among the populations investigated, does not exhibit any features out of the ordinary. We must therefore seek a class of explanation which will affect only one of the sexes. One such class of explanations which immediately presents itself is kinship structures and marriage patterns (Lévi-Strauss 1949). Not only will such factors influence the physical characteristics of the population, but due to the relatively greater mobility of women in most such structures, female populations are likely to be more influenced than male populations. It thus becomes necessary to invoke a combination of social and genetic factors in order to explain the observed distribution of statures in the female population of Västerhus. Further analysis of the possible causes of the observed pattern would require a much more detailed study than the present one, and one taking into consideration more anthropological features than stature.

In view of the above discussion, it is unfortunate that the Västerhus population in many cases has come to serve as a sort of standard against which other medieval populations have been compared, a situation due entirely
to the classic study by Gejvall (1960). The time has now become ripe for a reconsideration of this important material.

It is possible that the same general class of explanation also holds for Leksand, although the evidence, apart from the demonstrated skewness of the female population (Table 1), is much less clear. The preservation of this material was, however, poor (Sjøvold 1982), and this, together with the observed difference in the number of male and female skeletons in the material (though this difference is not statistically significant, $X^2 = 3.596, p>0.05$), suggests that preservational factors may account for at least some of the observed pattern in the Leksand material.

The major anomaly observed in the analysis of differences in stature between populations (Table 2) is the extremely short female population of Helgeandsholmen.

Once again, preservational factors cannot be ruled out, especially in view of the significant difference in the number of males and females in this material ($X^2 = 8.779, p<0.01$). This difference may perhaps be more profitably related to the socio-economic conditions peculiar to this site, however, which makes it plausible to consider factors intrinsic to the population. For reasons similar to the ones stated above for Västerhus, environmental factors may probably be ruled out as the cause of the observed pattern, and we are once again left with social and genetic explanations. In this case, the population, though short in stature, is not anomalous in any other way observed in this study, which leaves very little evidence to work from in the search for explanations. However, given the known socio-economic heterogeneity of the Helgeandsholmen material, it is possible that explanations can be sought in this area.

The final point to consider is the pattern of stature difference between males and females shown in Table 3. Here, Västerbjer and Löddeköpinge stand out in the fact that the stature difference between men and women in these populations is much less than in the others. For the first-mentioned population, there is no independent evidence for preservational biases, whereas in the latter there are significantly more males than females ($X^2 = 21.125, p<0.001$). Since there is no other demonstrated effect of this difference in either sex, I tentatively conclude that it has not influenced the stature estimates significantly. Given the hypothesis mentioned above, that nutritional factors will affect males more than females, it is tempting to relate the observed patterns to poor nutrition. Whether this is true of Västerbjer I cannot state from the information available to me. In the case of Löddeköpinge the available archeological information is contrary to this conclusion (H. Cinthio, pers. comm., 1984). However, if social and/or genetic factors are responsible for the observed patterns, some factor common to the two populations must probably be found, which at present seems unlikely. I conclude that an environmentally related explanation is the most plausible one in this case, although such an explanation must be considered with care and corroborated by independent evidence.

In conclusion, a few words should be said about the Neolithic population of Västerbjer. In this population both males and females are of relatively short stature. There is, however, no statistically significant difference in stature between the Neolithic females and the medieval ones. The Neolithic men, on the other hand, are significantly shorter than most medieval populations tested. Can we take this as an indication that males were shorter in Neolithic times than in medieval times? No, because if we look at the difference in stature between males and females (Table 3), we find that this figure is low for Västerbjer. We can again hypothesize that this is due nutritional deprivation affecting males more than females. If we bring this figure up to the level of a "normal" population, i.e. around 13 cm, by increasing the statures of males, we find that the difference between Västerbjer and the medieval populations has been eradicated. I have no data to say whether other neolithic populations were nutritionally deprived in the same way as Västerbjer, so the above discussion holds for the latter population only.

I hope to have shown in the present study
the value of a detailed analysis of the stature of earlier populations. Such analyses are, of course, not limited to stature, but may be carried out on any metric feature of the skeleton. Any such study is dependent on several things. The first and foremost of these is the availability of data. The present study would not have been possible if it were not for the fact that raw data have been published for some few skeletal populations. The only alternative would have been to remeasure all skeletons, an undertaking which was not reasonable in view of the limited scope of the study in other respects. I conclude that the routine publication of selected measurements, not just summary statistics or calculated statures and indices, is essential if inter-populational comparisons are to be at all undertaken.

From a methodological viewpoint, a crucial point in a study such as the present one is the careful consideration of the statistical distribution of the measurements. As seen above, this distribution can give valuable information on the population under study. Other features to be considered are mean stature, and difference in stature between males and females. The results of the analyses must then be related to their possible causes in an explicit way, so that other investigators working on other aspects of the same site can use the results in their own investigations, which may subsequently lead to reevaluation of the first data set. In this way archeology and physical anthropology can complement each other in the most useful and efficient way.

Acknowledgments

This study has benefited from valuable discussions with Drs. Elisabeth Iregren and Lars Redin, Museum of National Antiquities, Stockholm, and Mr. Hampus Cinthio, University of Lund. I would also like to thank Professor Nils-Gustaf Gejvall, Professor Torstein Sjovold, Dr. Ove Persson and Mrs. Evy Persson for having the foresight to publish the raw data upon which their respective analyses have been based.

References


Broberg, A. 1983. Debatt: osteologiska problem. META.


Sammanfattning


Skillnaden i kroppslängd mellan män och kvinnor i Löddeköpinge är liten i förhållande till de andra medeltida populationerna, vilket kan bero på näringsbrist. Det finns inga otvetydiga bevis för en förändring av kroppslängden från neolitikum till medeltiden. En noggrann statistisk analys av kroppslängder kan vara mycket avslöjande och ha betydande konsekvenser både i sig själv, och för arkeologiska analyser av en population och dess kultur. Möjligheten till sådana analyser är dock avhänig av tillgången på publicerade rådata, då skelettmaterialet är så omfattande att ommätning av dem för enstaka analyser är orimligt tidskrävande.

Fornvännen 80 (1985)