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Stature Estimation in a Central Patagonian Prehispanic Population: Development of New Models Considering Specific Body Proportions

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ABSTRACT Stature estimation of individuals from extinct human populations is a classic topic in anthropology. The estimations, using regression formulae generated from different reference samples, display different results. This fact is related to inter-populational differences in body proportions, which is a phenotypic trait mainly correlated with climatic parameters. The aim of this paper is to address the problem of stature estimation of an archaeological skeletal sample from Patagonia – a region for which there are no specific models available – using different methods and considering differences in body proportions between reference and target populations. The sample used in this analysis is composed of 35 Late Holocene adults of both sexes recovered in central Patagonia (Argentina). The stature of each individual was first reconstructed using the anatomical method [Fully G. 1956. Une nouvelle méthode de détermination de la taille. *Annales Medicine Legale* 35: 266–273], which has no assumptions on body proportions. The results were compared with estimations based on 32 different regression formulae [Trotter M, Gleser G. 1958. A re-evaluation of estimation of stature based on measurements taken during life and the long bones after death. *American Journal of Physical Anthropology* 16: 79–124. 10.1002/ajpa.1330160106] and three femur/stature ratios [Feldesman MR, Fountain RL. 1996. Race specificity and the femur/stature ratio. *American Journal of Physical Anthropology* 100: 207–224. 10.1002/(SICI)1096-8644(199606)]. The average reconstructed stature was 160.8 cm for females (95% confidence band = 155.6–166.2 cm), and 170.5 cm for males (95% confidence band = 168.8–172.2 cm). Most of the comparisons of the regression formulae and femur/stature ratios showed significant differences, which are explained by differences in body proportions between the Patagonian sample and the ones chosen as reference. Finally, a set of new equations was developed using simple regression techniques. It is suggested that whenever possible, population-specific formulae should be used in archaeological studies. In any other situation, the choice of a reference population should be made by taking into account its geographic (latitudinal) provenance. Copyright © 2009 John Wiley & Sons, Ltd.

Key words: stature estimation; body proportions; extinct hunter-gatherers; Patagonia

Introduction

The estimation of living stature from human skeletal remains has major relevance to biological anthropology. It provides important information regarding issues such as health and nutrition, sexual dimorphism and general trends in body size (Stini, 1969; Tanner, 1988; Bush, 1991; Auerbach & Ruff, 2004). Beginning in the 19th century (Rollet, 1888 in Telkkä, 1950), physical anthropologists have developed several stature estimation methods based on different segments of the human body, mostly single long bones, using skeletal samples from different parts of the world (Trotter & Gleser, 1952; Genovés, 1967; Olivier, 1976; Feldesman *et al.*, 1990; Sciulli & Giesen, 1993; Feldesman & Fountain, 1996; Formicola & Franceschi, 1996; Hens *et al.*, 2000; Özaslan *et al.*, 2003; Işcan, 2005 and the literature cited therein; El-Meligy *et al.*, 2005; Hauser *et al.*, 2005; Kondo *et al.*, 2005; Celbis & Agritmis, 2006).

It has been stated that formulae (i.e. regression equations intended to predict stature from long bones) are population specific, subsequently raising caution about the applicability of such models to individuals

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drawn from populations different from the reference one (Pearson, 1899; Telkkä, 1950). The estimation methods based upon one or two long bones, i.e. regression methods (Trotter & Gleser, 1958) and femur/stature ratio (Feldesman & Fountain, 1996) work under the assumption that the individuals of both the targeted and the reference populations have the same long bone-stature ratio. Nevertheless, this assumption is not always true or it cannot be reliably corroborated; such is the case of extinct populations. It is virtually impossible in most cases to have population-specific standards, particularly when ancient populations are the research target. This is an omnipresent problem. In fact, the general lack of comparative skeletal samples of known living statures is a major obstacle found in developing reliable stature estimation methods useful for the study of ancient populations (Işcan, 2005). However, this is a problem that can be, if not totally circumvented, at least controlled if careful attention is paid to the differential body proportions that populations display. The use of universal standards to estimate any biological parameter is progressively discarded when local values are known. Thus, it becomes necessary to approximate the living stature with the least error possible by applying population-specific models instead of universal standards or those from populations completely different from the one being studied.

Although body proportions vary in a spatiotemporal pattern as a function of climate (Ruff, 2002) and that this variation has an effect on the estimation of stature, there is a lack of stature estimation models in many geographic regions of the world. Southern South America is one of these regions. As a consequence, population-specific regression equations are often used to estimate stature of individuals whose body proportions may be significantly different (Barrientos, 1997; Onaha *et al.*, 2002; Méndez *et al.*, 2003). This, in turn, can have ulterior implications if it is transferred to further analysis of other models (i.e. body mass assessment, biomass, population density, etc.).

The aim of this study is to develop, evaluate and discuss stature estimation formulae of adult individuals from archaeological samples in central Patagonia, belonging to Late Holocene populations with no present representatives. The stature is anatomically reconstructed (Fully, 1956) in a central Patagonian sample. Then, the application of different existing techniques of stature estimation is assessed and compared, taking the anatomically reconstructed stature as a reference. Finally, new stature estimation equations are presented from the values drawn upon this sample.

Materials and methods

Samples

The skeletal material comes from central Patagonia burials and belongs to hunter-gatherer Late Holocene populations (*ca*. 2500–400 BP). The individuals come from two close geographical regions. The archaeological locality named Sierra Colorada (SAC) lies on the Salitroso Lake Basin (about 30 km west of the eastern slopes of the Andes) (47°25′S, 71°29′W) in the province of Santa Cruz in southwestern Argentina (Figure 1) (Goñi & Barrientos, 2004). The sample from SAC used in this work is restricted to those adult individuals whose remains were complete enough to perform the anatomical method outlined below. This selection resulted in a sub-sample of 16 individuals (i.e. 10 males and 6 females). The second sub-sample, housed at the División Antropología of the Museo de La Plata in Buenos Aires, Argentina, was collected in

Figure 1. Geographic localisation of the samples analysed.

the last decades of the 19th century by various museum expeditions (Lehmann-Nitsche, 1911) in the lower valley of the Chubut River, in the Chubut Province of southeastern Argentina (43°15′S, 65°18′W) (Figure 1). The sample consists of 17 male and 2 female complete adult skeletons.

The human osteological collection of the Museo de la Plata is the largest and most important in the country, especially for its post-cranial Patagonian samples. Regretfully, complete and reliable field notes from the early 19th century excavations are virtually non-existent. Therefore, the information contained within them is considered within the appropriate context. Despite these restrictions, it is possible to research this collection using more modern diagnostic tools and methods.

Since the early 20th century a number of studies have examined the limited samples of human remains recovered from sites in central and southern Patagonia (Guichón, 2000). Although in the last few years the quantity of artefactual evidence found in Patagonia has increased, the discovery of human skeletal remains has not increased accordingly. Thus, the difficulty is not the quantity of recovered elements but more related to issues of taphonomy, archaeological visibility and population density (Barrientos, 2002). Most human burials are isolated findings and/or contain highly fragmentary bones with pitiful preservation. Subsequently, such limited remains are often quite inadequate for the kind of studies performed in this work (Prieto, 1991, 1993–1994; Salceda *et al.*, 1999–2001; ĹHeureux *et al.*, 2003; Castro *et al.*, 2004; Hauser *et al.*, 2005; Gómez Otero, 2006; Raxter *et al.*, 2006).

Both male sub-samples were compared with regard to body proportions in order to evaluate the possibility of analysing them altogether. The Mann–Whitney *U*-test was applied with a 0.05 probability in the following ratios: crural index; talus-calcaneus articulated height/tibial length; sum of vertebrae (trunk)/lower limb length (tibial length + femur length); basion-bregma cranial height/sum of vertebrae and physiological femur length/sum of vertebrae. As there were no significant differences found in any of the ratios, samples from Chubut and Santa Cruz were pooled for the analysis. In addition, several craniometric studies (e.g. Perez *et al.*, 2004) support the biological homogeneity of these populations. This resulted in a larger single sample of 27 individuals. However, this sample size must be considered to evaluate the following analyses.

Age and sex determination

Age was estimated according to changes in the auricular surface of the ilium (Lovejoy *et al.*, 1985)

Table 1. Descriptive data on the sample and stature reconstructions (in centimetres) of Patagonian individuals by means of the anatomical method (Fully, 1956 with corrections suggested by Raxter *et al.*, 2006)

Sample	Male		Female	
	Age	Stature	Age	Stature
Chubut	20	167.69	21	158.37
	33	175.06	26	161.43
	20	175.23		
	37	168.08		
	28	167.48		
	20	168.97		
	39	167.38		
	28	168.25		
	23	176.34		
	34	162.51		
	30	172.57		
	20	171.02		
	39	170.42		
	41	171.60		
	29	167.37		
	30	173.06		
	45	171.20		
Santa Cruz	30	176.42	22	150.57
	47	177.17	22	154.43
	22	162.77	42	165.86
	50	172.76	42	170.23
	25	169.37	37	164.30
	30	177.27	30	161.53
	50	172.30		
	47	161.11		
	55	170.56		
	50	169.42		
n		27		8
Mean		170.50		160.84

and in the pubic symphysis (Brooks & Suchey, 1990; Ghidini, 2008 personal communication for Chubut individuals; García Guraieb, 2006 for Santa Cruz individuals). Mean range stature was used in the following analyses. More details about the samples are shown in Table 1. Sex was determined based on morphological observations and metric assessment of the pelvis, cranium and long bones. The sexing criteria considered in the innominates were ventral arc, subpubic angle, ischiopubic ramus (Phenice, 1969), greater sciatic notch width and preauricular sulcus (Buikstra & Ubelaker, 1994). The morphological traits considered in the cranium were those suggested by Buikstra & Ubelaker (1994). Head diameter of femur and humerus were analysed as sex indicators in long bones (Béguelin & Gonzalez, 2009).

Osteometrics

The skeletal measurements used in this research are cranial height (basion-bregma), maximum height of the vertebral body from second cervical (C2) through fifth lumbar (L5); maximum height of the first sacral vertebra; physiological and maximum femoral length (FLB and FLM correspondingly); tibial medial malleolus-lateral condyle length (TL); talus-calcaneus articulated height (T-CH); humerus and radius maximum length (HLM, RLM) (Fully, 1956; Martin & Saller, 1957; Raxter *et al.*, 2006). These variables were measured with a sliding caliper and an osteometric board.

Intra-observer error

The same observer (M.B.) who has previous experience in osteometric analyses performed all the measurements (recorded in millimetres) in order to avoid inter-observer error. Assessment of intra-observer error was performed using a sample composed by individuals from Patagonia. Operator inconsistency was evaluated by measuring the same set of variables in two events 2 weeks apart from each other. All the measurements show an acceptable level of consistency between observational series (Béguelin, 2009).

Stature estimation methods

The individual statures were first reconstructed through the anatomical method (Fully, 1956, following Raxter *et al.*, 2006, p. 5, Eq. 1). This technique consists of adding the length or height of every element that makes an individual's stature. A soft-tissue correction factor is added to this sum, and if the individual has a known age, it can be added as another correction factor. It is considered a reconstruction rather than an estimation given that all the bones that account for living stature are considered. Consequently, there are no assumptions on differences in body proportions when using this technique. Thus, an important advantage of the anatomical method is the relatively small difference between the predicted stature and the living stature. However, this is only the case when almost complete skeletons are available. The equation used includes a correction coefficient for age. Major changes in stature related to ageing, such as compression of vertebral bodies, are incorporated in the method by measuring the vertebrae themselves (see Raxter *et al.*, 2006 for further discussion on age changes).

Following this, two stature estimation methods – mathematical equations derived from the length of one or more long bones – were used to estimate stature in the Patagonian sample. The classical long bone regression equations developed by Trotter & Gleser (1952) were applied to the sample. Long bones produce the most precise estimations, given that they are highly correlated with stature (Damuth & MacFadden, 1990). This is the reason why most equations used to estimate stature are based on such bones. There is a wide variety of regression models built on different anatomical elements and on diverse human populations (Sciulli & Giesen, 1993; Özaslan *et al.*, 2003; Hauser *et al.*, 2005; Işcan, 2005). Stature estimation from regression techniques represents a single mathematical operation: the replacement of the measure in the corresponding equation. Regression equations used in such studies were generated with the least squares method. This method assumes random values only in the dependent variable, stature in this case. The female stature was assessed employing eight long bone regression formulae based on African-American and U.S. Whites' populations. The male stature was calculated using 19 long bone regression equations based on Mongoloids, Mexicans, African-American, and U.S. Whites' populations. An age-correction factor suggested by Trotter & Gleser (1951) was applied to the values obtained with both long bone equations and femur/stature ratio methods.

The statures were also estimated using 3 of the 55 published femur/stature ratios. These include Mesoamerican (sex-discriminated), Asiatic and generic (Feldesman & Fountain, 1996). The Mesoamerican and Asiatic ratios were chosen on the basis of the genetic closeness of the reference and the studied populations. The stature estimation method derived from the femur/stature ratio introduced by Feldesman *et al.* (1990), is a special case of a line equation, which intercept is equal to zero. This method, which is grounded on the fact that there is a higher correlation between femur length and body size than for any other skeletal bone (Damuth & MacFadden, 1990), consists of the calculation of stature from the femur length and a chosen ratio:

$$\text{F/S R} = \frac{\text{Femur length}}{\text{stature}} \times 100 \Rightarrow \text{Stature} = \frac{\text{Femur length}}{\text{F/S R}} \quad (1)$$

Feldesman & Fountain (1996) calculated the ratios for 55 populations around the world, many of them sex specific, and found an almost constant femur-stature ratio, regardless of sex or race. These authors also calculated a generic ratio that they found very useful due to its conservative nature. The generic ratio consists of the average of all the population's ratios' values.

Comparison of estimates and development of new models

Non-parametric Wilcoxon paired sample tests were used to compare each of the stature estimation methods with the anatomical method. To further estimate stature from different independent variables, simple regression equations derived from the male group were performed from the values reconstructed with the anatomical method. The assumptions of the regression method were formerly evaluated (i.e. homoscedasticity, with the Bartlett test, and normality, linearity and independence were evaluated by means of graphic methods).

The female sample was used to compare different methods but not to develop new models, given its small size.

Results

Statures obtained by means of the anatomical method are shown in Table 1; the average female stature is 160.8 cm (95% confidence band: 155.6–166.2 cm; $n = 8$) and 170.5 cm for the male group (95% confidence band: 168.8–172.2 cm; $n = 27$). Table 2 shows mean statures derived from F/S ratios and regression methods published for other populations as well as the probabilities of Wilcoxon matched pairs tests for male and female. The results of each stature estimation method were compared with the results of the anatomical method. Several significant differences were found within both groups. The outstanding result obtained from this analysis is that in different models derived from the same populations, none of the cases functions as adequate estimators of stature for the Patagonian samples used in this study.

Table 2. Mean stature estimation in centimetres calculated through different femur/stature ratios (Feldesman & Fountain, 1996) and regression equations on limbs long bones (Trotter & Gleser, 1952, 1958)

Method	Male	Female
	Mean stature	Mean stature
Anatomical	170.50	160.84
C F/S Ma	175.12***	166.34*
C F/S As	174.32***	163.50*
C F/S Ge	172.49*	161.79
Regr W H	169.85	159.90
Regr W R	176.36***	168.04*
Regr W F	171.80	160.92
Regr W T	176.72***	167.22*
Regr W F+T	173.78***	164.00*
Regr AA H	167.32***	158.09
Regr AA R	169.61	160.04
Regr AA F	167.54**	158.35*
Regr AA T	171.23	161.90
Regr AA F+T	168.75**	160.17
Regr MH	169.64	
Regr M R	173.15**	
Regr M F	171.61	
Regr M T	174.48***	
Regr M F+T	174.04***	
Regr Mx H	168.16**	
Regr Mx R	172.12	
Regr Mx F	171.12	
Regr Mx T	172.47**	

F/S R = femur/stature ratio; Ma = Mesoamerican; As = Asiatic; Ge = Generic; Regr = regression; H = humerus; R = radius; F = femur; T = tibia; W = U.S. whites; AA = African-American; M = Mongoloid; Mx = Mexican.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$ for non-parametric Wilcoxon matched pairs test between each method and the anatomical one.

The male statures obtained with the F/S R method significantly exceeds the values reconstructed for Patagonian samples. The equations for U.S. Whites overestimate significantly the Patagonian values for distal limb segments, i.e. radius and tibia as well as for the tibia + femur models. Instead, estimations for proximal elements do not differ from the anatomical method. Mongoloids' models show the same pattern described for U.S. Whites. Stature estimation from the Mexican femur equation does not differ significantly from that obtained with Fully's method. Tibia and humerus equations significantly overestimate and underestimate, respectively. The radius shows marginally significant differences ($p = 0.051$). The regression equations for African-American populations significantly underestimate Patagonian statures in proximal segments, i.e. humerus and femur, as well as tibia + femur models.

The female group presents many significant differences. The estimations done on the F/S R for Mesoamericans and Asiatic appear to be significantly larger, whereas the generic F/S R is not significant ($p = 0.123$). The regression equation for U.S. Whites based on the distal limb bones (tibia and radio) overestimates significantly the values obtained for Patagonia with the anatomical method. Significant differences were found between African-American equations and the anatomical method only for the femur equation.

Simple regression equations were developed from the values reconstructed with the anatomical method (Table 3). The regression equations are presented in a descending order of precision according to the standard estimation error (SEE). The stature estimation formula using TL and TCH + T + FLB showed the largest accuracy, while the formulae of FLB and HL provided the least accuracy.

Discussion

The results of this work show that all the F/S R overestimate the values obtained from the anatomical

Table 3. Stature regression models from different skeletal remains derived from Patagonian samples

	Formula (variables in cm.)	R^2	p	SEE
1	$71.60 + 2.54 \times$ TL	0.687	0.0000	2.11
2	$27.89 + 1.55 \times$ (TCH + T + FLB)	0.741	0.0000	2.25
3	$52.15 + .79 \times$ (TCH + TL + FLB + HL + RL)	0.605	0.0000	2.34
4	$64.95 + 1.25 \times$ (TL + FLB)	0.612	0.0000	2.35
5	$59.72 + 2.90 \times$ PL	0.656	0.0000	2.50
6	$75.48 + 2.06 \times$ FLM	0.500	0.0001	2.72
7	$140.68 + 0.55 \times$ (SUM VERT)	0.464	0.0002	2.77
8	$90.18 + 1.38 \times$ (HL + RL)	0.360	0.0025	2.98
9	$103.11 + 2.61 \times$ RL	0.336	0.0024	3.20
10	$105.83 + 2.31 \times$ UL	0.355	0.0027	3.28
11	$69.38 + 2.21 \times$ FLB	0.437	0.0002	3.32
12	$99.74 + 2.19 \times$ HL	0.288	0.0069	3.39

method. This would imply that the individuals under study have longer femurs in relation with Asiatic and Mesoamerican populations, as well as the generic mean. Notwithstanding this, stature estimates of regression methods using femur as a predictive variable are consistent with the results of the anatomical method in three out of four cases. Estimating stature on the basis of femur length is generally more accurate than using measurements of other bones. The F/S ratios were calculated for the Patagonian sample accounting for the anatomical method, being 26.95 the female ratio and 27.13 the male one. Significant differences between males and females were not detected (t-test $p = 0.436$). Among the 55 published F/S ratios (Feldesman & Fountain, 1996), those of African-American populations are the most similar to Patagonian ratios for females (26.80) as well as for males (27.46).

The male stature overestimation resulting from the regression equations of U.S. Whites shows that Patagonian long bones (except for the humerus) are relatively longer than in U.S. Whites' populations. Given that models including both tibia and femur overestimate the stature of the sample under study, it is reasonable to assume relatively shorter trunks in Patagonian individuals relative to individuals of U.S. origin. Similarly, the distal upper and lower limbs of Mongoloids are relatively shorter than the homologous limb of Patagonian individuals. Even though the results derived from Mexicans' regressions do not show a clear pattern, the equation involving femora seems to be consistent with Patagonian proportions. Besides this fact, there is an apparent slight discordance in the limb proportions of Patagonian and Mexican samples. The equation for the humerus tends to underestimate the stature, and those involving radius and tibia tend to overestimate it (estimation with radio is not significant, but there is a tendency $p = 0.051$). Regarding the African-American sample, Patagonian individuals present shorter proximal upper and lower limbs relative to stature. It is worth noting that even when a model derived from a certain population limb bone may display accurate results (e.g. male Mongoloid humerus), the rest of the bones from that population may not necessarily match in relation to the stature of the population under study (e.g. male Mongoloid tibia; see Table 3). In fact, this is reflecting the difference in body proportions among the populations.

Differences in results between regression and F/S R estimates (e.g. African-American ratio is similar to Patagonians' one, but stature is underestimated by the regression model based on femur length of the same population) can be explained by a detailed analysis of the statistical models. F/S R can be viewed as a regression model that includes the slope alone, neglecting the elevation of the line (intercept). Linear regression in turn, considers both, slope and intercept and encloses more information. Therefore, linear regression models could be preferable for estimating stature.

With regard to the female group, the estimations derived from the U.S. Whites' regression equations (Trotter & Gleser, 1958) overestimate the stature when using the distal segment of both upper and lower limbs. This means that the Patagonian female sample has a relatively longer upper and lower distal limb segments than U.S. Whites' populations. Instead, the African-American proportions seem similar to that of Patagonia except for the femur that underestimates statures. Still, these statements need to be proven using a larger sample.

Different human populations vary in their body proportions (Roberts, 1953; Stinson, 1990). At least some of these differences could be accounted for as climatic adaptations. For example, populations adapted to cold climate have short limbs relative to stature, while populations adapted to warm climate have longer limbs (Ruff, 1993, 1994, 2002; Holliday, 1997a).

These adaptations also affect intra-limb proportions (e.g. crural and brachial indices), a phenomenon that seems to be highly correlated with mean annual temperature (Trinkaus, 1981). The limb/stature and intra-limb proportions show a geographic arrangement following a latitudinal gradient (linked to climatic features, mainly temperature). In particular, Béguelin & Barrientos (2006) studied samples of Late Holocene hunter-gatherer populations from Patagonia and neighbouring regions, finding a clear geographic variation pattern in a latitudinal orientation. The samples, composed of adult male and female individuals, were arranged into four geographic groups corresponding to latitudinal bands of 5° widths each, beginning at 40° south. On the basis of femur maximum length and the brachial and crural indices, several intra- and inter-group statistical comparisons were performed. The results suggest that there is an intelligible pattern of geographic variation in the body proportions, which can be explained by the convergence of different factors and processes such as climatic adaptation and migratory movements. Thus the samples used for the present work differ in body proportions from the northernmost ones studied by Béguelin & Barrientos (2006), probably due to the influence of climatic factors. Therefore, the results of this work show that the differences in body proportions between Patagonian and other American and Asian populations greatly affect the stature estimations.

Method choice depends largely on the particular problem. The anatomical method requires a generally complete skeleton and is a highly time-consuming task. The regression and F/S methods can be easily applied having the length of a single bone, which represents a substantial saving of time, *albeit* in detriment of estimation accuracy. Thus, the anatomical method offers advantages when estimating stature because it tends to more closely approximate living stature, based on the fact that the technique is developed from actual body proportions. This method is highly recommended when all of the bones needed to perform it are available (Raxter *et al*., 2006). Unfortunately most archaeological skeletons are incomplete, so other methods are required such as regression equations linking a single long bone to the stature built on the same population under study. In many cases this is not obtainable, so regression formulae from other populations can be used, considering the geographical region as a criterion to choose the reference population.

In this work, a number of simple regression equations have been developed from a central Patagonian archaeological sample. These models are recommended to estimate the stature of a population geographically close or with similar body proportions instead of other commonly used methods. The regression equations developed from Patagonian samples (see Table 3) are, for the moment, the only ones made from autochthonous populations in southern South America. Considering the issues mentioned above, like the misleading results of methods derived from one population and applied to another, the models presented here are more reliable for local samples than other methods commonly used (e.g. Trotter & Gleser, 1958; Genovés, 1967).

Conclusions

In this work it has been established from a Late Holocene Patagonian sample that the body stature estimation, using formulae calculated on a different population, may produce misleading results. Depending on the bone used to predict the stature, there is quite a significant level of variation. Thus, the results obtained reinforce the statement that there is a remarkable influence of body proportions on stature estimation. This is not surprising since stature is a general parameter of body dimensions, recognisably linked to biogeographical aspects (Baker, 1988; Holliday, 1997b; Gustafsson & Lindenfors, 2004; Weinstein, 2005; Pfeiffer & Sealy, 2006). In Patagonia, the body proportions of ancient populations vary at least in relation to latitude, a proxy measure of climatic variation (Béguelin & Barrientos, 2006). All this evidence suggests that a biogeographically (environmental) informed selection of the method is critical in order to improve the predictions of ancient population statures.

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