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Archaeological and Anthropological Sciences (2023) 15:191
https://doi.org/10.1007/s12520-023-01900-7

RESEARCH

Assessment of stature in Iron Age populations of South Africa

Maryna Steyn[1,2]

Received: 21 August 2023 / Accepted: 9 November 2023 / Published online: 22 November 2023
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Abstract
Worldwide and in South African Stone Age contexts, much research has been done on the relationship between stature of past populations and general well-being, as well as trends and patterns in stature through time. This research is aimed at collating and assessing all available stature and long bone data for Bantu-speaker individuals living in the South African Iron Age. Data for only 25 female and 32 male individuals, dating from circa AD 550 to AD 1823, could be found. In general, methods used to reconstruct stature were inconsistent and data were poorly reported. From the available data, no clear trends or patterns in stature through time could be observed and stature seems to be on a par relative to those of early twentieth century individuals. Recommendations are made as to which methods to use in stature estimations in this context. The data provided in this research can serve as reference material for future similar studies and can assist in interpreting individual stature estimations from bioarcheological research in the region.

Keywords Long bones · Regression equations · Femur-to-stature ratio · Stature estimation

Introduction

Stature, and changes in stature, are often used to gain information on health and well-being of past and present populations (e.g., Komlos 1994; Tanner 1994; Steckel 1995; Vercellotti et al. 2014; Mays 2016). It should, however, be kept in mind that final adult stature is the result of many factors, the most important of which is genetics (e.g., Tanner 1994; Bogin et al. 2001; Mathieson et al. 2015). Tobias (1972) was one of the first researchers to provide general information on stature of historic South Africans. Much more research has since been added on stature in past populations, with studies by Sealy and Pfeiffer (2000) and others (e.g., Kurki et al. 2010; Pfeiffer and Harrington 2011; Kinahan 2013), particularly in Late Stone Age (~ 10,839 BC to 1493 AD; Lombard et al. 2022) groups in southern Africa, providing examples of how growth and stature in autochthonous groups can help us to understand the influence of environmental and other factors on body size.

In their paper, Sealy and Pfeiffer (2000) provide maximum femur lengths and femoral head diameters, with dates, for a large number of Stone Age Holocene individuals from the Southern Cape, South Africa. Among other things, they found a pattern of stability among already-small San people, with a noteworthy increase in diversity and decline in mean body size from ca. 3,300 to 2,000 BP. Before 2,000 BP, the people of smallest stature were often also those who ate mostly terrestrial foods. After this date, this pattern no longer holds true. Very small people, all apparently women, occurred from 4,000 to 2,000 BP.

This was followed by several other studies with similar themes (e.g., Sealy 2006; Pfeiffer and Sealy 2006; Pfeiffer 2012) which reflected on the relationship between small body size and population density, food availability and types (through isotopic analysis), trauma, and possible sexual selection. Other themes explored aspects of body size (Kurki et al. 2010, 2012), child growth (Pfeiffer and Harrington 2011), and activity patterns (Stock and Pfeiffer 2004).

These papers, mainly focusing on Stone Age hunter- and gatherer populations, show the value of looking at body size and stature, as well as trends in stature across time, as it reflects the general adaptation and well-being of populations as well as possible environmental changes. Stature is of

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course dependent on both environmental and genetic factors (Niskanen et al. 2018). In the changing landscape of southern Africa, with its continuous migrations and diffusion of populations, it is hard to separate genetic influences (e.g., the short stature of the Khoe-San) with changes that may have been brought on by environmental stressors or the absence thereof.

Unfortunately, much less research of this nature has been done on Iron Age (~ 100 to 1840 AD) Bantu-speaker populations of South Africa, with stature reconstructions usually mentioned in passing as part of individual skeletal reports. In most older publications of the early twentieth century dealing with human skeletal remains, unfortunately, the focus was on the identification of racial characteristics of skulls (see Morris 2022) with hardly any emphasis on anything related to the postcranial skeleton. Most of these early papers do not report on the long bones at all and do not make any attempt to reconstruct stature.

These practices changed somewhat by the 1970s, with physical anthropologists such as De Villiers (1972; 1973) including stature reconstructions in her reports, sometimes (but rarely) with attempts to bring it into a greater context. Unfortunately, De Villiers and others (e.g., Wells 1935) mostly do not report raw measurements, but rather provided reconstructed statures. At the time, population-specific stature reconstruction formulae were not available, and formulae developed by Trotter and Gleser (1952) developed for North American populations were often employed in earlier publications. More recently, other methods (e.g., Lundy and Feldesman 1987; Feldesman and Fountain 1996) became available and were used in skeletal reports. It is not clear from the literature exactly which methods are the most appropriate for the reconstruction of stature in South Africans and, particularly, in Iron Age Bantu-speaker individuals.

The aim of this paper is to assess the availability of long bone and stature data relating to Iron Age Bantu-speaker remains in South Africa, and to investigate which methods were used to reconstruct stature. An overview of available methods will be provided for practitioners not so familiar with the topic, as a guideline to use in such estimations—this will include recommendations of what to use for South Africans and in this case particularly for the skeletal remains of Iron Age Bantu-speakers. All long bone and stature data from the literature, as well as unpublished reports, will be collated in order to assess for trends in stature in the past 2000 years, in an attempt to add information on the health and well-being (and perhaps possible genetic influences) of these individuals.

Stature reconstruction in archeological populations

It is widely accepted in the forensic anthropological context that population-specific formulae should be used to reconstruct stature (e.g., Ross and Konigsberg 2002; İşcan and Steyn 2013; Koukli et al. 2021). This, of course, is problematic when it comes to past populations and if ancestry/population is not known. It has conclusively been demonstrated that long bone lengths versus overall stature vary in different populations, and this is most probably related to the well-known associations between climate and body proportion (Allen 1877; Ruff 1993; Feldesman and Fountain 1996). Generally speaking, individuals in warmer climates have longer limbs relative to their overall heights, as a heat adaptation. The opposite is true for people living in colder climates. Of course, this picture becomes confounded in modern populations where people no longer live in their ancestral lands.

One of the oldest methods of stature estimation is the use of a femur-to-stature ratio, as it was found that there is a relatively constant relationship between femur and overall stature in various populations across the world (Dupertuis and Hadden 1951; Sjovold 2000). The femur-to-stature ratio of various groups worldwide was assessed in detail by Feldesman and Fountain (1996) using a large and diverse sample of individuals from various regions of the world—from Eskimos to pygmy populations. The femur-to-stature ratio of Black African population groups was shown to be different from the generally observed value of 3.74—i.e., where maximum femur length multiplied by 3.74 (SD 4.4 cm) provides a stature estimate (Feldesman & Fountain 1996; Sjovold 2000). According to Feldesman and Fountain (1996), the femur length constitutes approximately 26.75% of the stature across all ancestry groups (translating to the ratio of 3.74) but 27.13% in individuals of African descent and 26.48% in individuals of European decent—demonstrating the somewhat longer limbs in Africans. While there are slight differences between males and females, they advise one generic formula—in the case of individuals of African descent, the formula:

$$\text{Stature} = 30.285687 + (2.986895 \times \text{femur})[\text{SEE not provided}]$$

should be used, as this regression formula gives a slightly better result than using the ratio itself. It should be noted that the femur length to be used in this formula is the maximum femur length, recorded in cm (in standard reports, both maximum and physiological length are usually recorded, with the physiological length being shorter than the maximum length). An advantage of this method is that it provides an estimate of the living stature, and it is not necessary to add a soft tissue correction factor (as is necessary for the anatomical method based on total skeletal height, TSH, introduced by Fully 1956). A disadvantage is that the ratio does not provide an estimate of the uncertainty around this point estimate—other traditional formulae usually provide an SEE (standard error of estimate) that allows one to provide a stature estimate with a 95% confidence interval.

The largest disadvantage of using femur-to-stature ratios in archeological populations, as opposed to other methods to assess stature, however, is the fact that the femora may not be complete or not preserved at all and that maximum femur length is therefore not available. Other long bones and measurements are therefore often used to estimate the stature.

In South Africa, the formulae of Lundy and Feldesman (1987) are widely used in modern and archeological cases concerning Black Africans. However, it should be taken into account that these formulae provide an estimate of the total skeletal height (TSH)—i.e., it reconstructs the proportion of the stature that is made up by the skeletal elements. From here, this value should be adjusted to account for soft tissues—for a TSH of less than 153.5 cm, 10 cm is added; for a TSH 153.5 to 163.5 cm, 10.5 cm must be added for a THS of more than 163.5 cm, 11.5 cm is added (Fully 1956). More recently, Raxter et al. (2006) provided new, generic (worldwide) soft tissue correction factors which are commonly in use to convert TSH into living stature. If no correction for the age of an individual is made, living stature = 0.996 × skeletal height (TSH) + 11.7 (SEE 2.31).

Unfortunately, in South Africa, it has been shown that these soft tissue correction factors, and especially that of Lundy and Feldesman (1987) consistently underestimate stature (e.g., Bidmos and Manger 2012; Brits et al. 2017). The new Bidmos and Manger (2012) corrections for South African black males have been criticized due to some technical issues (Ruff et al. 2012a), while that of Brits et al. (2017) are commonly in use for black females. This does leave a conundrum, because it means that in the South African context, there is no reciprocity between males and females when living stature is reconstructed from TSH using the most recent soft tissue corrections. Until firmly established soft tissue correction factors are established for African males, it is therefore advised that the Raxter et al. (2006) soft tissue corrections are used in archeological settings. These are in use worldwide, but are not population-specific and may underestimate stature in South Africans.

A word of caution—for the Trotter and Gleser (1952) formulae specifically, there is some confusion as to exactly how the tibiae were measured (Jantz et al. 1994; Mays 2016)—the tibiae can be measured as maximum lengths (with medial malleolus) or physiological length (without the malleolus). The physiological lengths are also reportedly sometimes recorded with calipers rather than an osteometric board. This confusion makes the use of the tibia unpopular, and should tibial formulae be used the exact manner of recording, as used in the publication providing the formulae, should be established. Similarly, some formulae require the use of maximum femur length, whereas others use the physiological/bicondylar femur length. De Villiers, in her 1981 unpublished report on the Broederstroom, Munro, and Olifantspoort remains, for example, provides the maximum femur lengths (FeL1), but then goes on to say that the Lundy formulae were used to reconstruct stature—these, however, use physiological/bicondylar length. Reported statures, without providing raw data, are therefore problematical.

In general, when several long bones are available, the bone or combinations of bones with the highest correlation to stature should be used. In most sets of formulae, the femur usually has the highest correlation to actual stature, followed by the tibia. In the upper limb, the radius is usually the best correlated to stature (but less so than the lower limb bones).

Pfeiffer and Sealy (2006) in a paper on body size of Holocene foragers from the Cape ecozone clearly encountered the same difficulties when having to deal with different methods to reconstruct stature. They used the regression equations proposed by Feldesman and Fountain (1996), the generic femur-to-stature ratio of 26.74 proposed by Feldesman et al. (1990) and the sex-specific equations for black and white individuals developed by Trotter (1970). These problems with stature estimation are not unique to South Africa and have been debated in several other regions of the world (e.g., Ruff et al. 2012b; Kinahan 2013; Mays 2016; Ruff et al. 2019). This demonstrates the difficulty with obtaining comparable stature data from long bone lengths across populations, especially with varying degrees of preservation of remains.

Materials and methods

For this study, reported long bone and stature data of southern African Iron Age Bantu-speaker individuals, focusing on individuals from the pre-colonial era, were collected. Only individuals with firm dates were included or individuals that came from archeological sites that were firmly dated. Only adult individuals, or late adolescent individuals with complete epiphyseal closure, were included. Individuals were divided by sex.

For each individual, depending on the data available, the following were calculated/recorded:

- Stature based on the Trotter and Gleser (1952) formulae for black Americans (Terry Collection), as these were sometimes used by De Villiers, also in reports where raw long bone lengths were not provided
- Stature based on the Lundy and Feldesman (1987) formulae for modern black South Africans, using the original (Fully 1956) soft tissue correction factors
- Stature based on the Lundy and Feldesman (1987) formulae for modern black South Africans, using the Raxter et al. (2006) soft tissue correction factors. The general formula, not corrected for age, was used as age estimates were often not available
- Stature based on the femur-to-stature ratio for Africans, using the regression equation of Feldes-

man and Fountain (1996) where living stature = 30.285687 + (2.986895 × femur maximum length)
– Where no long bone data were recorded, but a stature was published, this was included as a "reported stature"

For all cases, only the point estimate (without SEE) was used for purposes of comparison. The statures of individuals, using the various methods, were compared in order to assess for, for example, consistent over- and underestimation. Unfortunately, the actual, living stature is of course not available and therefore these can never be assessed for real accuracy.

In order to assess if changes in stature occurred, individuals were divided into Huffman's (2009) descriptions of Early, Middle, and Late Iron age. While not all archeologists would agree with this division, it provides a convenient way to compare statures across time periods. Following this, Early Iron Age (EIA) individuals were dated to AD 100–900, Middle Iron Age (MIA) to AD 900–1300, and Late Iron Age (LIA) to AD 1300–1840. Within each of these time periods, the mean statures were calculated—e.g., mean stature of EIA females and mean stature of MIA females. Mean statures across the three time periods, for females and males, respectively, were assessed using ANOVA to establish if stature changed significantly. For this purpose, SPSS (Statistical Package for Social Sciences; Version 26.0) was used.

As these individuals were all dated, or came from dated sites, stature versus date was plotted on a graph to visually assess trends and scatter. For this purpose, the midpoint of the reported AD dates was used for each individual as the raw (before present) dates were often not available. This is of course only a wide approximation of the date of each skeleton, but it assists to graphically assessing the available data.

Results

The raw data, with reported long bone lengths per individual, are shown in the Supplementary material (S1) for future use in similar studies. It also shows the full detail of each skeleton, as well as the reference for each entry (full reference list in S2).

The availability of long bone or stature data from the South African Iron Age is disappointing. For the Early Iron Age (as per the definition above), information for only two males and two females could be obtained. For the MIA, data were available for 6 females and 13 males, while the corresponding numbers for the LIA were 17 (female) and 16 (male). This brings the total sample to $n = 56$ individuals (Table 1).

Table 1 reflects the reconstructed statures for each individual, using various different methods. Only the point estimates, without SEE's, are included here, for easy comparison. Overall, the formulae of Trotter and Gleser (1952) provided relatively tall estimates, clearly out of line with other formulae. The Lundy and Feldesman (1987) formulae with the soft tissue corrections of Raxter et al. (2006) provided slightly taller estimates than the original soft tissue corrections, as expected. The femur-to-stature ratio (as per the regression) of Feldesman and Fountain (1996), in general, provided estimates that were slightly taller than the Lundy and Feldesman (with Raxter et al. corrections) formulae (1.4 cm on average; two were taller and the remainder shorter). These ratios still provided statures that were shorter than those using the Trotter and Gleser (1952) formulae.

In each individual case, and for further comparison, a judgment call was made as to which stature estimate was most probably the most accurate for each individual. As the Lundy and Feldesman (1987) formulae with Raxter et al. (2006) soft tissue corrections are often criticized because they tend to underestimate stature (Bidmos and Manger 2012; Brits et al. 2017), the Feldesman and Fountain (1996) femur-to-stature ratio was deemed the most accurate (where maximum femur lengths were available), followed by the Lundy and Feldesman (1987) formulae with the Raxter et al. (2006) soft tissue corrections (also used for cases where only physiological length of the femur was reported). Estimates using the femur was preferred over those using the tibia, with the radius usually deemed the next best choice. However, in some individuals, only a single long bone such as a fibula or humerus length was available and had to be used. In 14 cases, no raw data (long bone lengths) were recorded and only a reported stature was available—in some cases, e.g., Glennel, the author stated which method was used (Trotter and Gleser in this case), whereas in others (e.g., Eersteling), no information was given as to how the estimate was derived. For the Broederstroom female, in an unpublished report, De Villiers quoted a stature estimate of 150 cm although it was not clear on what it was based—a maximum tibia length was recorded but did not correlate with a 150 cm reconstruction, creating some confusion and the reconstructed stature was retained.

Average statures of females were 152.0 cm in the EIA ($n = 2$), 159.3 in the MIA ($n = 6$), and 158.8 cm ($n = 17$) in the LIA, with no clear trend visible ($p = 0.500$). A similarly non-directional, not significantly different ($p = 0.645$) pattern, was seen in males, where average stature was 171.6 cm ($n = 2$) in the EIA, 166.4 cm ($n = 13$) in the MIA, and 167.1 cm ($n = 17$) in the LIA. Overall, female stature ranged from 143.2 (Newcastle 2007/006) to 179.9 cm (Thulamela, UP 43) with an overall mean of 158.4 cm ($n = 23$; SD 7.906). For males, the shortest stature was 156.4 cm (Munro) and the tallest 185.8 cm (from Clarens, an MIA site). The overall mean for males is 167.1 cm (SD 7.101).

The data are graphically represented in Fig. 1, where a wide scatter can be observed. What is once again obvious

Table 1 Stature reconstruction using various formulae. Stature estimates are shown in cm

Individual	Period	Sex	Reported	T&G	L&F	L&F Raxter	Fem ratio	Final
Broederstroom A4143	EIA	Female	150.0	163.8				150.0
Mhlopeni PMB 80/2.1b	EIA	Female		161.4	161.6	162.7	153.9	153.9
							Mean	**152.0**
Happyrest UP1	EIA	Male		175.1	170.8	171.4	173.7	173.7
KwaGandaganda PMB001	EIA	Male		172.2	167.2	167.8	169.5	169.5
							Mean	**171.6**
K2 A1722	MIA	Female		154.8	148.5	149.6	151.6	151.6
K2 A1730	MIA	Female		158.9	152.9	154.0	156.9	156.9
Mapungubwe A624	MIA	Female		170.6	170.1	170.7	172.2	172.2
Pilanesberg UP51	MIA	Female			150.1	151.2		151.2
Glennel 1/1 D35.1.1	MIA	Female	160.0	160.0				160.0
Glennel 2/1	MIA	Female	164.0	164.0				164.0
							Mean	**159.3**
Clarens A4237/4231	MIA	Male		183.7	181.5	181.0	185.8	185.8
K2 A1714	MIA	Male			162.0	163.1		163.1
K2 A1732	MIA	Male		168.2	161.6	162.7	163.8	163.8
K2 A1734	MIA	Male		184.0	173.2	173.8		173.8
K2 A1758	MIA	Male		163.7	155.7	156.8	157.5	157.5
K2; KS58	MIA	Male		167.0			162.2	162.2
Mapungubwe A619	MIA	Male		175.8	173.1	173.6	174.6	174.6
Kon-Stayt UP77	MIA	Male			167.7	168.3		168.3
Schroda NAS2AA.3(i)0.1	MIA	Male	169.7	169.7				169.7
Glennel 1/1 A25.1.1	MIA	Male	169.5	169.5				169.5
Glennel 1/1 B26.1.1	MIA	Male	161.0	161.0				161.0
Mapungubwe UP145	MIA	Male		160.6	156.6	157.7		157.7
Munro burial 2	MIA	Male		156.4				156.4
							Mean	**166.4**
Askoppies NASB1	LIA	Female		155.5	149.8	151.0	152.2	152.4
Champagne C PMB2009/023	LIA	Female		157.6	150.7	151.8	155.1	155.1
Cyferkuil UP94	LIA	Female		171.9	161.9	163.0		163.0
Eersteling A410c	LIA	Female	157.8					157.8
Ellerton Mine A414	LIA	Female	156.2					156.2
Lindley UCT326	LIA	Female	156.0	156.0				156.0
Newcastle 2007/006	LIA	Female		149.6	142.1	143.2		143.2
Pilanesberg UP95	LIA	Female	161.4		161.4			161.4
Thabazimbi UP132	LIA	Female		154.8	144.7	145.9		145.9
Thulamela UP43	LIA	Female		176.5	176.3	175.8	179.9	179.9
Wellington Estate A1103	LIA	Female		164.2	159.6	160.7		160.7
Wellington Estate A1836	LIA	Female		160.3	168.1	168.6		168.6
Wellington Estate A2235	LIA	Female	160.7					160.7
Willow Glen UP 72	LIA	Female		162.0	157.3	158.4		158.4
Klip River Valley UCT UCT329	LIA	Female	160.0	160.0				160.0
Olifantspoort A4221	LIA	Female		164.2	159.9	161.0	163.8	163.8
Olifantspoort A2853&2854	LIA	Female		162.5	156.2	157.3		157.3
							Mean	**158.8**
Kaybar's Cave A294	LIA	Male		172.0	167.0	167.7	169.2	169.2
Kaybar's Cave A295	LIA	Male		165.0	159.3	160.4	159.3	159.3
Makapanstad UP	LIA	Male			160.5	161.6		161.6
Makgope UP48	LIA	Male		172.0	167.5	168.1	169.2	169.2
Makgope UP49	LIA	Male		168.2	162.7	163.7	163.8	163.8

Table 1 (continued)

Individual	Period	Sex	Reported	T&G	L&F	L&F Raxter	Fem ratio	Final
Modimolle UP92	LIA	Male		168.8	163.1	164.2	164.7	164.7
Nwanetsi UP130	LIA	Male		168.5	161.7	162.8	-	162.8
Pilanesberg UP139	LIA	Male		181.2	178.8	178.3	182.3	182.3
Pilanesberg UP143	LIA	Male	166.5			166.5		166.5
Robinson's Shelter A302	LIA	Male		174.7	169.9	170.4	173.1	173.1
Skukuza Rock Shelter UP29	LIA	Male		172.3	165.4	166.0		166.0
Thulamela UP44	LIA	Male		172.3	165.4	166.0		166.0
Welgegund UP12	LIA	Male	166,1					166.1
Wellington Estate A1838	LIA	Male		162.1	157.8	159.0		159.0
Yellowtree Shelter A299	LIA	Male		169.4	164.4	164.9	165.6	165.6
Olifantspoort burial 5	LIA	Male		187.8	179.5	179.0		179.0
							Mean	**167.1**

Mean values per sex per time period are shown in bold

EIA Early Iron Age, *MIA* Middle Iron Age, *LIA* Late Iron Age, *T&G* Trotter and Gleser, *L&F* Lundy and Feldesman, *L&F Raxter* Lundy and Feldesman with Raxter Corrections, *Fem ratio* femur-to-stature ratio

from Fig. 1 is that the data from the EIA is very limited, with peaks around the LIA and the K2/Mapungubwe (MIA) period (circa AD 1000 to 1300). As expected, males are generally taller than females, although some overlap is evident.

Discussion

The availability of long bone data lengths and stature for individuals from the South African Iron Age is disappointing, and the reasons for this—relative to the much more numerous Stone Age data from the southern provinces—can be debated. It possibly reflects the preoccupation of early physical anthropologists with "race" and the San/KhoeSan populations of southern Africa, where excavations focused on cave sites along the coast that yielded large numbers of skeletons. Perhaps it is also related to a general perception that we know much about the relatively recent incoming Iron Age agriculturalists, and that their histories are somehow less interesting. This is most certainly not true as, for example, the recently reported MIA dating of surprisingly tall, robust, and craniologically different people from Clarens in the Drakensberg region shows (Landsman et al. 2022). Clearly, there are much to be learned. However, this lack

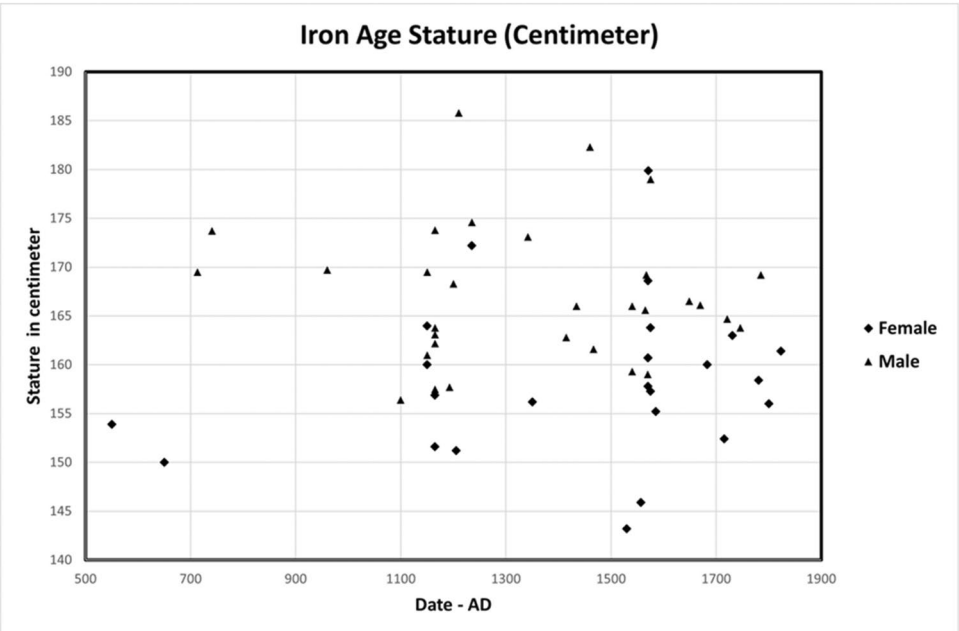

Fig. 1 Stature of males and females across the Iron Age

of data seems to be the case for various southern African regions (e.g., Kinahan 2013), and it is clear that research lags behind in some regions of the subcontinent.

The majority of larger skeletal assemblages in South Africa result from large-scale excavations done in the first half of the twentieth century (e.g., from Matjes River, Whitcher's Cave, Mapungubwe/K2). While these were done in haphazard and unscientific ways (e.g., see Morris 2022), they did result in large (but often commingled) assemblages from a specific site. Recent additions of human skeletal remains to skeletal collections are rare and mostly result from inadvertently (often single) discovered graves, which are excavated as part of rescue operations (e.g., the skeletons from Cyferkuil, Modimulle, and Nwanetzi included here). Unfortunately, the accompanying archeological data from these are limited. This is unlikely to change in future, as excavation of human remains is now exceedingly rare. It is therefore important that remains in collections, which are often under-studied, should be reassessed, properly cataloged, and analyzed.

In general, skeletal data from Iron Age Bantu-speaker populations are limited. What is imperative is that when skeletal reports are published, basic, raw data are recorded and reported. Then, at least the most appropriate methods of analysis can be selected or direct comparisons of long bone lengths made. For now, the array of methods used to reconstruct stature is confusing. While the femur-to-stature ratio seems to provide reliable statures, the problem is that femora, and specifically maximum femur lengths, are not always available. For now, we are probably best off to use either the Feldesman and Fountain (1996) ratios when they are available or alternatively the formulae of Lundy and Feldesman (1987) with the Raxter et al. (2006) soft tissue corrections.

No clear trends in stature across the last circa 1500 years could be observed from the available data, as confirmed by the non-significant p-values of the ANOVA analyses. From this, one may be tempted to propose that the environmental and general nutritional status did not change much, but this is almost certainly an oversimplification, even taking the limited data set into account. If the variation of stature in specific individuals is considered, some interesting patterns are seen. For example, the shortest of the female individuals—Newcastle (2007/006)—shows a 13.3% Khoe-San admixture from her autosomal DNA profile, although other genetic indicators (see Steyn et al. 2019) clearly show a West-African, Bantu-speaker origin. Is it conceivable that the limited Khoe-San genetic contributions could have contributed to her short stature? The tall Thulamela female (179.9 cm, UP 43) is also interesting—she was a high-status individual (royal because she was tall, or perhaps came from elsewhere through a marriage arrangement?) (Steyn et al. 1998). Her mtDNA tentatively aligned her with eastern African peoples (Bodiba et al. 2019), as opposed to the Thulamela male who aligned more with western peoples. The second tallest female (172.2 cm) A624 was also a high-status individual from Mapungubwe Hill. This possible pattern of taller statures for high-status individuals has been described before (Haviland 1967; Brødholt et al. 2023) although the patterns are complex and not always clear-cut (e.g., Robb et al. 2001).

Of the males, the Clarens individual A4237/4231 was the tallest (185.8 cm)—as mentioned before, the early date, coupled with a very robust-looking group of individuals, makes these individuals interesting. Craniologically, they did not align with any of Howell's groups of African individuals included in Fordisc (Jantz and Ousley 2005), and their origins are not currently clear (Landsman et al. 2022). The EIA Happy Rest male (UP 1) and the high-status Mapungubwe hill male (A 619) were among the taller males, as was UP 139 from Pilanesberg and A 2857 from Olifantspoort. It is clear that adult statures are thus the products of gene flow, social status, and general health. More data are needed.

Tobias (1972) reported on the stature of various African groups—mostly from people in the first half of the twentieth century. Unfortunately, mostly male data are included for Bantu-speakers. South African black groups with known statures mostly fell in the "medium" stature group, described by Tobias as having mean statures between 160 and 170 cm. This correlates well with the mean stature of 167.1 cm reported here, tentatively suggesting no significant changes from the Iron Age through to the early twentieth century. Tobias does provide mean statures for Venda and Zulu females only, which are in the range of 150 to 160 cm—also similar to the 158.4 cm reported for females in this study, although their means were actually somewhat less and ranged between 154.0 and 156.4 cm.

For now, we can thus not comment on changes in stature throughout the IA and also into the early twentieth century, but hopefully, this data will stand as a possible reference source for future studies. It may also help in the interpretation of stature estimates in individual cases, as it provides a baseline against which statures can be interpreted. Overall, this paper also demonstrated the confusion that can arrive with the use of different formulae, but we will have to continue to use stature estimates (as opposed to femur lengths alone) as they can include remains of varying preservation. However, this is not without its problems and methods should be clearly described and raw data provided.

Conclusion

This paper assessed the practices used to estimate stature in Iron Age Bantu-speaker populations from South Africa and assessed the available data on remains from this time period. Overall, methods used were inconsistent, poorly reported,

and unclear. There is an overall paucity of long bone data and stature estimates, making the assessment of overall trends and interpretations difficult. With the availability of data, no clear trends could be observed and statures seem to be on par with that reported for early 20th-century individuals. All currently available stature data are reported here and can form the base for future similar studies.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12520-023-01900-7.

Acknowledgements I would like to thank Roelof Blignaut and Deona Botha for their assistance. The previous work of Alan G. Morris in compiling a catalog of human skeletal remains is also acknowledged—this was a very helpful resource for this work. There are references for various unpublished manuscripts (individual skeletal reports) in the text, which are available from the author on request.

Author contributions Maryna Steyn is the single author of the paper. Responsible for conceptualization, collecting and analyzing data, writing.

Funding Open access funding provided by University of the Witwatersrand.

Data availability All data used for this study are available in the supplementary material. To access the remains, individual curators will need to be approached.

Declarations

Competing interests The authors declare no competing interests.

Ethical approval This research forms part of a larger study to sample skeletal remains for aDNA and dating, for which approval has been obtained from the Raymond A. Dart Archeological Human Remains Collection committee at the University of the Witwatersrand. All other information was obtained from published sources. An Ethics Waiver (Ref: WvN-230913–01; HREC, University of the Witwatersrand) was obtained for this research.

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