Adult stature in southern African Negroes — further evidence on the absence of a positive secular trend

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Summary

The continuing search for data bearing on secular changes of adult stature in disadvantaged or Third-World communities led to the analysis of two sets of data. One was unpublished but was kindly made available by Professor H.C. Seftel, and was based on a study of 5 018 adult and sub-adult male black subjects living in Johannesburg. The other dealt with black miners and the relevant data on adult and sub-adult stature had been published by Dr J.G.D. Laing. Both sets of results were analysed by the method of age-ranking of the cross-sectional data and correcting them, where applicable, for 'personal shrinkage' after 30 years of age. The former results proved suitable for the analysis and the reduced data showed clear evidence that the Johannesburg population concerned had *not* been subject to a secular trend towards increased adult mean stature over the period c. 1919 — c. 1950. This is a further example, over and above those already adduced from studies in Asia, Africa, Meso- and South America, that many of the world's agrarian and pastoral communities have shown an absent or even a negative secular trend, during some of the time that First-World populations have shown a a positive secular trend. The data for black miners proved to be too heterogeneous for this approach to be applied validly to them.

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The study of growth changes, sexual dimorphism and secular trends in adult stature enabled the author, more than two decades ago, to recognise that the Kalahari San (Bushmen) provided the first evidence from the African continent of a secular trend towards increased adult mean stature.[1] Not long afterwards, his largely fruitless search for evidence of a similar positive trend among other African peoples, and the finding instead of absent or opposite trends, led the author to claim that a number of non-industrial, disadvantaged African peoples had betrayed either an absence of secular changes or even what he proposed be called a negative secular trend of mean adult stature.[2-12]

Independently and, at the time, unbeknown to the author, G. Kenntner presented a doctoral thesis, 'Die Veränderungen der Körpergrösse des Menschen'[13] to the University of Saarland, West Germany. In this still unpublished thesis, Kenntner collected data from 39 countries or geographical zones for which earlier and later data on mean adult stature were available. He found that 24 of the populations surveyed had shown an increase in mean adult stature over the previous 50-100 years, while in 12 there had been no change over that period and in 2 — Koreans and Chileans — there had been an apparent decline. Thus, the phenomenon of *absent* secular trend was widespread, while the *negative* secular trend of mean adult stature seemed to be exemplified by a scattering of populations in Africa, Asia and South America.

To the originally observed populations of southern African Negroes, the author added further examples showing an absence of a positive secular trend, from Namibia, Malawi, Angola, Kenya and Uganda in Africa. Vogel[14] showed a probable negative secular trend in adult mean stature for Kanets (Rajputs) of the Kulu Valley in the north Indian Himalayas, while Professor D.P. Mukherjee of Calcutta informed the author, during the

Silver Jubilee Congress of the Indian Anthropological Society in December 1983, that he had unpublished evidence that many other Indian groups were growing shorter, not taller (personal communication). Eveleth *et al.*[15] reported the absence of a positive secular trend among the Xingu Indians of Brazil, while Frisancho *et al.*[16] demonstrated a negative secular trend in the height of lowland, Quechua-speaking children from Pamashto in Peru. Similarly, absent or negative secular trends have been shown among Guatemalan Indians[17] and Mexican Zapotecs.[18,19]

Among observations dealing with much earlier periods, we may cite Steffensen's[20] revelation, based on the long bones of Viking Age Icelanders, that mean calculated stature dropped in the 18th century by about 5,0 cm, or 1,0 cm per generation, before it rose by 10 cm to its 20th century value. Tobias[10] and Tobias and Netscher[11] used the same approach to lay bare a 'reversal of the usual [i.e. positive] secular trend' in the lengths of femora derived from cadavers of South African blacks, as did Price *et al.*[12] more recently.

Steegman,[21] using personnel data from a British infantry regiment spanning the late 18th century, showed a marked negative secular trend of mean adult stature which declined from 1 705 mm for men born between 1749 and 1753 to 1 673 mm for those born in the period 1769-1774. These historical trends revealed by Steffensen[20] and by Steegman[21] were associated with food shortages and other factors at the times of birth and development. However, in the assignment of causes of secular changes, a simplistic approach, although tempting, is unjustified, as Hooton,[22] Cone,[23] Tanner,[24,25] and Meredith[26] have stressed.

One of the besetting problems in the study of secular trends in Africa has been to find adequate and reliable data bearing on stature in earlier periods. The use of long limb-bone lengths from dateable skeletons has already been mentioned. Another method is to use cross-sectional data and to rank the mean stature values in age-classes.

Recently, new data suitable for this kind of analysis came into the author's hands. As the picture of past height values and changes in South African Negro peoples is still far from clear, it is the aim of this article to place on record new data and to attempt to draw inferences from them, bearing on secular changes in some African peoples.

Subjects and methods

If one possesses a large number of stature measurements made on adult members of a population varying in individual ages from, say, 26 years to 75 years, then clearly those who are in the 71-75-year cohort were born and nurtured earliest of those measured, while those in the 26-30 year cohort were born and grew up most recently. Moreover, if one proceeds to age-rank the data, one may derive mean adult statures for each of the age-ranked cohorts. Now, if such a population has been subject to a positive secular trend, one would expect a decline in mean cohort statures with the age of the cohorts, the younger adults representing a generation that had grown up under those conditions producing greater mean adult stature.

It is important, however, to bear in mind and to correct for the 'normal' decline in stature of each individual with advancing age. The amount of such ageing needs to be assessed by longitudinal studies, such as that of Miall *et al.*[27] From this study and that of Trotter and Gleser,[28] an estimate has been arrived at of 0,6 mm as the average loss of stature for each year after the age of 30 years.

If then we find that the younger age cohorts in our adult population are taller, while the older cohorts have smaller mean stature values, we may draw one of two possible conclusions. (We accept the universality of bodily shrinkage with age.) Either (*i*) 'normal' ageing changes have occurred in the individuals over 30 years of age, *without* a concomitant positive secular trend towards increased mean stature of the younger adults; or (*ii*) 'normal' ageing shrinkage has occurred *as well as* a secular trend towards increased mean stature of the younger adults.

To determine which alternative obtains in any population, it is necessary first to attempt to correct for the 'normal' shrinkage with age. One way of doing this is to add on to the stature measured in each individual an amount equal to 0,6 mm multiplied by the number of years by which his age exceeds 30 years. Alternatively, the correction may be effected to each cohort's mean stature, by adding on to the mean stature, as calculated, a value equal to 0,6 mm multiplied by the number of years by which the mean age of the cohort exceeds 30 years. (If the mean age of the cohort is not available, the mid-value of the range of ages represented in that cohort may be used as a second-best basis for the computation of the correction factor for each cohort.)

After obtaining corrected cohort means, the investigator then inspects these values and tests the significance of any residual decline in mean stature with age to determine whether or not a positive secular trend is evident.

The *absence* from a population of a significant trend towards diminution of corrected mean stature with age can mean only that the 'normal' ageing changes in individuals have been compensated for by the absence of any secular changes, or by the presence of a negative secular trend, over the period of time spanned by the oldest and youngest cohorts. That is to say, the shorter size of the older adults as a result of personal shrinkage is offset by the younger adults being of virtually the same size as, or shorter than, those of an earlier generation. Hence, if sampling techniques and sizes are adequate, and the determination of individuals' ages is correct, the absence of a significant decline in mean adult stature in cross-sectional cohorts of different ages may be accepted as valid evidence for the absence or reversal of a positive secular trend.[4,15]

An early application of this approach was that of Kark[29] in a study of Zulu people at Pholela in Natal. Dividing his data into age cohorts, he found no significant decline in stature with age between 20 years and 50 years (even without correcting for personal shrinkage). He commented that there was an apparent tendency for the Zulus of that day to be shorter as adults than their forefathers had been.

The data that have now been made available to the author by the generosity of Professor H.C. Seftel of the Department of Medicine, University of the Witwatersrand and Hillbrow Hospital, were measurements of stature and mass on some 10 000 Johannesburg blacks. They were studied during the period June-November 1973 as part of a public health medical examination. Some 130 000 men and 28 000 women were examined, of a total black population of Johannesburg estimated to have been of the order of 1 million at that time. The study group consisted of some 5 018 men and 5 018 women, selected at random from the totals examined.[30] The investigators placed at my disposal the statures, weights, ages and gender of the 10 000 examinees.

The data for stature have been converted from inches to millimetres and have been age-ranked by myself. The results for stature of adult male blacks are presented.

It should be mentioned that the black population of Johannesburg comprises South African Negroes of diverse national and chiefdom origins. De Villiers[31] has drawn attention to the fact that detribalisation is occurring to a marked degree in the Johannesburg area, within which the subjects of the present study were measured. The main populations represented may be expected to have been of Cape Nguni, Natal Nguni, Transvaal Ndebele, Sotho, Shangana-Tonga and Venda origin. From Professor Seftel's survey, such data on chiefdom or national

origin were not furnished and the data are thus of a pooled sample of black South Africans.

Results

Johannesburg adult males (Table I)

The overall mean stature for the 5 018 adult South African Negro men in Seftel's 1973 series from Johannesburg has been computed as 1 689,3 mm. The mean age for this series is 30,8 years. However, the total mean stature is based on all readings including those for cohort 1, 16-18 years. The low mean value for this cohort, 1 662,6 mm, confirms that this group of sub-adults had not attained adult stature: its mean stature is no less than 31,8 mm less than the mean for cohort 2 (19-28 years). If then we omit cohort 1 from the analysis, the overall mean for the 4 629 men in cohorts 2-6 is slightly greater, namely 1 691,5 mm.

If we examine the uncorrected mean stature values for cohorts 2-6, we see a steady drop from 1 694,4 mm for the youngest group to 1 677,2 mm for the oldest. As mentioned above, these declining values with age may be accepted as reflecting 'personal shrinkage' alone, or age shrinkage *and* a positive secular trend. To dissect the two possibilities apart, the cohort means have been corrected for 'personal shrinkage': the correction factors, estimated not on an individual but on a cohort basis, are given in the 4th column of Table I and the corrected values in the 5th column.

The correcting for personal age shrinkage yields somewhat higher values for the overall means. For the entire sample of 5 018 subjects the corrected mean is 1 692,3 mm; when we omit the sub-adult cohort 1 the residual series of 4 629 individuals has an overall mean of 1 694,8 mm. This figure is virtually identical with the corresponding value (1 694,9 mm) for Laing's[32] 1 526 adult black miners after exclusion of the youngest individuals and after correction of the residual data for 'personal shrinkage' (Table II).

If we examine the corrected mean values in the last column of Table I, from cohorts 2-6, we see that the successive mean values no longer reflect the steady drop shown by the uncorrected cohort means in the 3rd column of Table I. There are slight fluctuations in mean values, but these are of doubtful significance. If we compare the corrected values for the youngest and oldest cohorts, we see that the mean for cohort 6 is exactly 2,0 mm greater than the mean for cohort 2 — and a span of about 40 years separates the birth dates of individuals in these two cohorts!

There is thus clear evidence of the *absence of an age-related decline* in corrected stature within the Johannesburg black peoples examined. That is to say, those subjects born more recently are not taller than those born in earlier years; there is a hint that those born earlier than 1915 (cohort 6) were a shade taller; those born in the decade 1915-1924 (cohort 5) showed a drop in mean stature; from 1925 to 1934 (cohort 4) the value rose again to what it had been up to 1914; 1935-1944 (cohort 3) saw a small drop and this slightly reduced stature was maintained by cohort 2, whose members had birth dates between 1945 and 1954.

Southern African adult black miners

The overall mean stature for the 1 855 mineworkers from South Africa, Swaziland and Lesotho, as measured and published by Laing,[32] is given as 1 684,3 mm. Laing divided his data, culled before March 1964, into 5 age cohorts in his Table V, reflected in my Table II. However, the total of the individuals in these 5 cohorts is 1 816, not 1 855. It is assumed therefore that there must have been another 39 individuals, probably of uncertain age, whose stature and mass data have been included in the overall means but cannot be embraced within any of the 5 cohorts. If we omit the estimated values for these 39 subjects, we derive a new mean of 1 689,9 mm for the 1 816 subjects in cohorts 1-5. This value is very similar to the uncorrected mean (1 689,3 mm) for the 5 018 men in the 6 cohorts of Johannesburg blacks (Table I).

Laing's[32] cohort 1 covered the age group 17-20 years. It therefore probably included a number of adolescents who were still growing.[3,33] This view is confirmed by the low mean stature (1 672,3 mm) for cohort 1, which value is no less than 17,6 mm smaller than the mean for cohort 2. Cohort 1 has therefore been omitted from the further analysis of Laing's series. Cohorts 2-5, comprising 1 526 subjects, have a somewhat greater overall mean — 1 693,2 mm.

The residual uncorrected mean values for cohorts 2-5 of the miners contrast with the Johannesburg cohort values in showing no clear trend with age. One gains the impression that the 'personal shrinkage' factor has been overlaid and masked by other factors. Corrections for age shrinkage have been effected in the last column of Table II.

These corrections for 'personal shrinkage' result in higher values for the overall mean statures. Thus, for the total of 1 855 miners, the mean value rises from 1 684,3 mm to 1 685,7 mm; that for cohorts 1-5 from 1 689,9 mm to 1 691,3 mm (N=1 816); and that for cohorts 2-5 from 1 693,2 mm to 1 694,9 mm (N = 1 526). The final figure, which has been corrected in two respects — by exclusion of the still-growing sub-adult subjects, and by adjustment for individual age shrinkage — amounts to 1 694,9 mm.

TABLE I. STATURE IN SUB-ADULT AND ADULT MALE BLACKS OF JOHANNESBURG —RAW MEANS FOR AGE-RANKED COHORTS AND MEANS AFTER CORRECTION FOR 'PERSONAL SHRINKING' BEYOND 30 YEARS OF AGE

Age cohort (yrs)	No.	Mean stature (mm) (uncorrected)	Correction factor	Mean stature (mm) (corrected)
1 (16-18)	**389**	**1 662,6**	**0**	**1662,6**
2 (19-28)	**2 262**	**1 694,4**	**0**	**1694,4**
3 (29-38)	**1 239**	**1 692,5**	**+2,1**	**1694,6**
4 (39-48)	**668**	**1 688,6**	**+8,1**	**1696,7**
5 (49-58)	**336**	**1 680,1**	**+14,1**	**1694,2**
6 (59+)	**124**	**1 677,2**	**+19,2**	**1696,4**
Total (1-6)	**5 018**	**1 689,3**	**—**	**1692,3**
Total (2-6)	**4 629**	**1 691,5**	**—**	**1694,8**

Based on data of Professor H.C. Seftel, 1973.

TABLE II. STATURE IN SUB-ADULT AND ADULT MALE BLACK MINERS FROM SOUTH AFRICA, LESOTHO AND SWAZILAND — RAW MEANS FOR AGE-RANKED COHORTS AND MEANS AFTER CORRECTION FOR 'PERSONAL SHRINKAGE' BEYOND 30 YEARS OF AGE

Age cohort (yrs)	No.	Mean stature (mm) (uncorrected)	Correction factor	Mean stature (mm) (corrected)
Other	**39**	—	**0**	—
1 (17-20)	**290**	**1 672,3**	**0**	**1672,3**
2 (21-35)	**473**	**1 689,9**	**0**	**1689,9**
3 (26-30)	**378**	**1 711,2**	**0**	**1711,2**
4 (31-35)	**230**	**1 682,2**	**+1,8**	**1684,0**
5 (⩾36)	**445**	**1 687,1**	**+4,8**	**1691,9**
Total	**1 855**	**1 684,3**	—	**1685,7**
1-5	**1 816**	**1 689,9**	—	**1691,3**
2-5	**1 526**	**1 693,2**	—	**1694,9**

Based on data of Laing.[32]

This value obtained from 1963 data published in 1964 is the same as the doubly-corrected 1973 value for Johannesburg blacks. The data suggest that, if the two series have been drawn from comparable populations, no change in mean adult stature was evident in the decade 1963-1973. However, it must at once be added that Laing's series[32] was drawn from mine-workers: although 24% were 36 years and over, probably few were 40 years and over; whereas 22,5% of Seftel's Johannesburg blacks were 39 years and over. Moreover, the Johannesburgers were city dwellers of varying degrees of urbanisation, while the miners were drawn largely from rural areas; furthermore, the tribal 'mix' in the urban areas is unlikely to be the same as in the regionally recruited mining group. Hence, it is not valid to compare the overall means for Seftel's 1973 series with those for Laing's 1964 series if one wishes to derive meaningful results bearing on possible secular changes.

If, instead, we examine the corrected mean values for cohorts 2-5 in the last column of Table II, we detect greater fluctuations than obtained in the Johannesburg series. Thus, the youngest men, in cohort 2, fall short in mean stature by no less than 21,3 mm compared with cohort 3; the latter, in turn, exceed the corrected mean value of cohort 4 (31-35 years) by 27,2 mm; finally cohort 5, comprising subjects >36 years old, has a cohort mean value 7,9 mm greater than that of cohort 4.

To put it in another way, of the examined miners, those born in and earlier than 1927 (cohort 5) had a fairly high cohort mean of 1 691,9 mm. The 230 subjects born between 1928 and 1932 (cohort 4) were definitely shorter, as adults; but in the following quinquennium (1933-1937) the members of cohort 3 attained much greater adult proportions (1 711,2 mm). So great was this change in a mere 5 years as to force one to abandon the notion that it could have reflected a powerfully positive secular change in the same or a comparable population. It seems more likely that the populations represented by cohort 3 and the other cohorts were not comparable (see below). (The agency recruiting mineworkers might have spread its net more widely at that time and included a greater number of recruits from one or more populations of taller people. This will be discussed below.) Then the 473 subjects born in 1938-1942 (cohort 2) were once more similar in cohort mean stature (1 689,9 mm) to the mean value for cohort 5. If we disregard the seemingly aberrant value for cohort 3, it appears that from about 1925 to 1940 there has been no tendency for later-born subjects to be taller than earlier-born ones. Indeed, if we exclude cohort 3, there is a tendency for later-born miners to be slightly shorter than earlier ones, the difference in cohort means being a drop of 2,0 mm over some 15 years or 0,13 cm decline per decade.

Our concerns over the homogeneity and thus comparability of the different cohorts comprising the series of miners grow when we contrast the range of cohort mean values for the black miners with the range for Johannesburg-dwelling black subjects. Among the miners, between the biggest and smallest values of cohort means is an interval of 27,2 mm, whereas among the Johannesburgers the interval is only 2,5 mm. This contrast is compounded by the fact that the former span only 15 years, the latter 40 years. One might have expected that cohort means (whether 5-year or 10-year cohorts) would range more widely over a longer span of time than over a shorter — but the opposite is the case here!

Even if we jettison the anomalous mean value for cohort 3, there still remains a range of 7,9 mm between the highest and lowest values of the residual group means — more than 3 times that for Seftel's city blacks.

If other things were equal, these oscillations might tempt one to raise the question of whether city-dwellers are more buffered than rural people against those causal influences — be they what they may — that are responsible for secular changes. But other things are not equal. Clearly the nature of the series of miners is such as to raise serious doubts whether, from one quinquennium to another, the mines' recruiting agency hired miners from precisely the same areas. Changes of policy, local demographic trends and other extraneous factors have certainly influenced recruitment. This would have resulted in quite different tribal, ethnic and geographic compositions of the annual intake of black recruits to work on the mines.

That the quinquennium 1933-1937 must have witnessed a fairly dramatic switch of this nature is clear from the fact that the germane cohort is the only single sub-set in this entire analysis to have an adult mean stature value falling in the anthropological category 'tall' (1 700-1 799 mm). In an analysis of 90 male populations of southern African Negroes, no fewer than 77 had adult mean stature values in the 'medium height' category (1 600-1 699 mm); 1 population fell into the 'short' category (1 500-1 599 mm) and 12 in the 'tall' category (1 700-1 799 mm).[3] Nine of the 12 populations with means in the tallness range were in territories to the north-west and north of South Africa, namely Angola, Zambia, Namibia and Botswana; only 1 was from the areas covered by our miners' series — namely Cipriani's[34] small group of Eshowe Zulu (1 703,7 mm; $N = 30$).

These considerations compel one to abandon the age-ranked cohorts of Laing's mining series[32] as a basis from which one may validly make inferences bearing upon secular changes in mean adult stature. However, his data on national, ethnic and tribal sub-sets of African Negro miners remain potentially

useful for this kind of analysis and will be examined by the author elsewhere.

Discussion

Two sets of data on the statures of adult southern African Negro men have been age-ranked and analysed for evidence of secular changes in mean stature.

A series of stature determinations was made on a sample of Johannesburg black subjects as part of a general medical examination of over 150 000 men and women. Age-ranking of the data and the correcting of the age cohort means for age-dependent 'personal shrinkage' provided a series of results clearly testifying that black adults born more recently (1945-1954) were *not* taller than those born in earlier decades (back to about 1910-1914). In other words, this community has not shown a positive secular trend towards increased adult mean stature. The data suggest that there has been either an absence of significant change over the 40-odd years spanned by the ages of the subjects in this series, or a slight tendency towards a minute diminution of stature over the 4 decades: the overall change is 2,0 mm over 40 years or 0,05 cm per decade. In contrast, it may be mentioned that Meredith,[26] generalising from a number of sets of findings, on populations that *have* been subject to positive secular change, set the magnitude of the secular *increase* in mean stature over the past century as 0,6 cm per decade in early adulthood.

It is concluded that the black population of Johannesburg provides a further example of a population that has shown no evidence of a positive secular trend in adult mean stature. In previous studies, the author found evidence that this was true of several other negroid populations of southern Africa: these were based on three different methodologies — the comparison of earlier and later metrical results on the same population; the measurement of limb-bones of earlier and later sub-sets of cadavers drawn from the same population,[4,5,12] and age-ranking of cross-sectional metrical data.[29]

The second set of metrical data considered here, namely measurements by Laing[32] on southern African Negro miners, proved unsuitable for the determination of secular trends by the method of age-ranking of the results. If age-ranked data had been available for each regional, national, chiefdom or ethnic sub-set making up the entire sample, and if the sample size in each age cohort had been adequate, we could have applied this method of analysis, with reasonable hope that we should obtain valid results. Unfortunately, Laing furnished age-ranked means for only the entire sample. With diverse geographic and chiefdom components, it is clear that the series of black mineworkers was too heterogeneous to be regarded as a 'natural' population; moreover, and *a fortiori,* it is manifestly also chronologically or longitudinally heterogeneous — that is, its ethnic or geographic make-up appeared to vary from age-cohort to age-cohort.

It is concluded that the method of age-ranking of cross-sectional anthropometrical data for the detection of the presence or absence, and the direction, of secular changes, may be used only when one is dealing with a 'natural', relatively homogeneous, population or at least one whose composition of disparate elements does not vary markedly from one time-period to another.

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REFERENCES

1. Tobias PV. On the increasing stature of the Bushmen. *Anthropos* 1962; **57:** 801-810.
2. Tobias PV. Puberty, growth, malnutrition and the weaker sex — two new measures of environmental betterment. *The Leech* 1970; **40:** 101-107.
3. Tobias PV. Growth and stature in Southern African populations. In: Vorster DJM, ed. *The Human Biology of Environmental Change.* International Biological Programme — Human Adaptability. Blantyre, Malawi, Meeting 1971. Blantyre: IBP, 1972: 96-104.
4. Tobias PV. Stature and secular trend among Southern African Negroes and San (Bushmen). *S Afr J Med Sci* 1975; **40:** 145-164.
5. Tobias PV. Anthropometry among disadvantaged peoples: studies in South Africa. In: Watts ES, Johnston FE, Lasker GW, eds. *Biosocial Interrelations in Population Adaptation.* The Hague: Mouton, 1975: 287-305.
6. Tobias PV. The secular trend in African peoples. In: Brink AJ, Lewis CM, eds. *Mankind and Medicine in the Third Millennium.* Parowvallei: University of Stellenbosch, 1978: 64-74; and Discussion 92-93.
7. Tobias PV. Variants of the secular trend in the mean stature of adult human populations. *J Anat* 1978; **126:** 668.
8. Tobias PV. The negative secular trend. *J Hum Evol* 1985; **14:** 347-356.
9. Tobias PV. War and the negative secular trend of South African blacks with observations on the relative sensitivity of cadaveric and non-cadaveric populations to secular effects. In: *Proceedings of the 5th Congress of the European Anthropological Association, 1986.* Lisbon: EAA, 1988: 451-461.
10. Tobias PV, Netscher D. Evidence from African Negro skeletons for a reversal of the usual secular trend. *J Anat* 1976; **121:** 435-436.
11. Tobias PV, Netscher D. Reversal of the usual secular trend, as evidenced by South African Negro crania and femora. *Mitt Anthropol Ges (Wien)* 1977; **103:** 233-239.
12. Price B, Cameron N, Tobias PV. A further search for a secular trend of adult body size in South African Blacks: evidence from the femur and tibia. *Hum Biol* 1987; **59:** 467-475.
13. Kenntner G. Veränderungen der Körpergrösse des Menschen. Ph.D. thesis, University of Saarland, Karlsruhe, 1963.
14. Vogel C. Wachstum und Dentition der männlichen Rajput-Jugend im Kulu-Tal (nordindischer Himalaya). *Homo* 1971; **22:** 28-37.
15. Eveleth PB, Salzano FS, De Lima PE. Child growth and adult physique in Brazilian Zingu Indians. *Am J Phys Anthropol* 1974; **41:** 95-102.
16. Frisancho AR, Borkan GA, Klayman JE. Pattern of growth of Lowland and Highland Peruvian Quechua of similar genetic composition. *Hum Biol* 1975; **47:** 233-243.
17. Bogin B, MacVean RB. Growth status of non-agrarian, semi-urban living Indians in Guatemala. *Hum Biol* 1984; **56:** 527-538.
18. Malina RM, Selby HA, Buschang PH, Aronson WL. Growth status of school children in a rural Zapotec community in the Valley of Oaxaca, Mexico, in 1968 and 1978. *Ann Hum Biol* 1980; **7:** 367-374.
19. Malina RM, Selby HA, Buschang PH, Aronson WL, Wilkinson RC. Adult stature and age at menarche in Zapotec-speaking communities in the Valley of Oaxaca, Mexico, in a secular perspective. *Am J Phys Anthropol* 1983; **60:** 437-449.
20. Steffensen J, Stature as a criterion of the nutritional level of Viking Age Icelanders. Prióji Vikingafundur, Third Viking Congress. Arbók hins ístenska fornleifafélags, fylgirit, 1958: 39-51.
21. Steegman AT. 18th century British military stature: growth cessation, selective recruiting, secular trends, nutrition at birth, cold and occupation. *Hum Biol* 1985; **57:** 77-95.
22. Hooton EA. *Up from the Ape.* Revised ed. New York: Macmillan, 1946.
23. Cone TE. Secular acceleration of height and biologic maturation in children during the past century. *J Pediatr* 1961; **59:** 736-740.
24. Tanner JM. *Growth at Adolescence.* Oxford: Blackwell, 1962.
25. Tanner JM. The secular trend towards earlier physical maturation. *Tijdschr Soc Geneeskd* 1966; **44:** 524-539.
26. Meredith HV. Findings from Asia, Australia, Europe and North America on secular change in mean height of children, youths and young adults. *Am J Phys Anthropol* 1976; **44:** 315-326.
27. Miall WE, Ashcroft MT, Lovell HG, Moore F. A longitudinal study of the decline of adult height with age in two Welsh communities. *Hum Biol* 1967; **39:** 445-454.
28. Trotter M, Gleser G. The effect of ageing on stature. *Am J Phys Anthropol* 1951; **9:** 311-324.
29. Kark SL. Patterns of health and nutrition in South African Bantu. M.D. thesis, University of the Witwatersrand, Johannesburg, 1954.
30. Seftel HC, Johnson S, Muller EA. Distribution and biosocial correlations of blood pressure levels in Johannesburg blacks. *S Afr Med J* 1980; **57:** 313-320.
31. De Villiers H. The cranium of the Bantu-speaking South African Negro: a comparative study. M.Sc. dissertation, University of the Witwatersrand, Johannesburg, 1957.
32. Laing JGD. A height/weight table for African mine labourers. *J S Afr Inst Min Metallurgy* 1964; March, 406-417.
33. Smit PJ, Potgieter JF, Fellingham SA. Body measurements of children of four racial groups from Pretoria. *S Afr J Nutr* 1967; **3:** 50-68.
34. Cipriani L. Osservazioni antropometriche su indigeni asiatici e africani: III, Zulu; IV. Batonga. *Arch Antropol Etnol* 1930-1931; **60-61:** 189-286.