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Anthropometrical evaluation of elderly blacks in the Orange Free State

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Abstract

The anthropometry of elderly blacks (65+ years) was investigated in order to provide a set of values for future reference and comparison with known studies. Four hundred blacks aged 65 years and older were randomly selected from ten towns in the Orange Free State and admitted to the study after informed consent had been obtained from them. The subjects' height, weight, upper-arm circumference and skinfolds (triceps, biceps, supra iliac and subscapular) were measured. Body mass index and bone-free upper-arm muscle area were calculated. It appears that South African elderly blacks are shorter in stature and the males are leaner than persons in the same age group in developed countries. Elderly black females in South Africa appear to be heavier than their male counterparts, and compare well with groups of elderly females in other studies. The findings suggest that sets of reference values derived from studies in developed countries are not applicable to the South African black elderly population.

Anthropometrical evaluation is an inexpensive method for the evaluation of the nutritional status of an individual. For this purpose several sets of reference values for children and adults were published in the past (Burr & Phillips, 1984; Womersley, Durnin, Boddy & Mahaffy, 1976). During the past few decades several studies were published on anthropometrical reference data on elderly populations worldwide (Burr & Phillips, 1984; Frisancho, 1984; Master, Lasser & Beckman, 1960; Harris, Cook, Garrison *et al.*, 1988; Vir & Love, 1980; Chumlea, Roche & Mukherjee, 1986; Yearick, 1978; Netland & Brownstein, 1985; Simonopoulos & Van Italie, 1984.) Reference data for anthropometrical indices of the elderly black person in southern Africa are however sparse. It is known that anthropometrical indices for groups living in different geographical areas differ from one another (Tobias, 1985). Secular trends (changes over long periods) in respect of stature also differ in groups of people worldwide (Tobias, 1972b, 1975b, 1985).

Elderly black people will form an increasingly important group as far as health services in the southern African context are concerned, due to an expected large increase in the number of elderly blacks (Watermeyer & Bourne, 1984) and a tendency for elderly people to make greater use of health services than younger people. The clinical reference data, of which anthropometrical data constitute an important part, regarding this subpopulation will therefore become increasingly important for effective and appropriate health care.

This study investigated the anthropometry of elderly blacks in order to provide a set of reference values which could also be used in comparisons.

Materials and methods

Sampling method

All towns in the province of the Orange Free State with black populations of 1 500 or more, according to the 1985 population census data, formed the sampling frame; ten towns were randomly selected, with weighting for population size. According to the 1985 census (with its limitations), the total population of 338 575 in the selected towns constituted 64,5% of the total urbanized black population of the Orange Free State.

Allowing for a highest expected prevalence of 30% for any particular variable studied and an acceptable error of 5%, the sample size, calculated for 95% probability, was 323 persons. It was decided to admit 400 persons to the study. The male-to-female ratio of South African blacks aged 65 years or older, according to the Human Sciences Research Council's adjustment of the relevant 1985 census ratio, is 1:1,15. One hundred and eighty two males and 218 females were admitted to the study, giving a male-to-female ratio of 1:1,20. Informed consent was obtained from all participants in the study.

Plot numbers were randomly selected in each of the towns and the number of study participants selected in each town weighted according to population size. Selected addresses were ignored if the plot was not a residential plot; if no elderly person was resident on the plot; or if the required number of participants of the same sex as the elderly person(s) on a particular plot had already been obtained. An elderly person was defined as a person aged 65 years or older.

In order to achieve a sample of 400, a total of 3 791 plots were visited. There were 25 non-responders, giving a non-response rate of 6,3%. A non-response was recorded if a selected person refused to participate in the study; if that person could not be contacted at home despite three attempts; or if the person was out of town for the duration of the research team's visit to that town. The non-responders were replaced by continuing with the original lists of random plot numbers. In view of the low non-response rate it was considered that this action would not seriously bias the results.

To enable objective respondent selection within a household when more than one elderly person was resident on a selected plot, a modification of the Kish procedure (Kish, 1949) was used; all elderly persons on such a plot were listed alphabetically, one being selected at random.

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Measurements

Height. Height was measured with the participant wearing underclothes and no shoes. The feet were placed together and the head was held in the Frankfurt horizontal plane, with the person standing erect. The measuring column was a "SECA" type which consisted of a vertical bar (calibrated in cm) attached to a level platform. Attached perpendicularly to the vertical bar was a horizontal beam which was brought down on the participant's head.

Weight. A "SECA" beam balance was used to measure body mass. This scale was calibrated daily before measuring began. Weight was recorded to the nearest 0,2 kg. The participants were weighed without shoes and only in their underclothes.

Skinfolds. Triceps, biceps, supra iliac and subscapular skinfolds were measured with a Harpenden skinfold caliper to the nearest mm. Skinfolds and upper-arm circumferences were measured by the standard technique described by Weiner and Lourie (1969). All measurements were done on the right side of the body, although no statistical difference was found between measurements on either side of the body during previous studies (Durnin & Wormesley, 1974). Three measurements were made and the median reading recorded. The participants were in a sitting position, with the arm relaxed and the elbow 90° flexed. A flexible steel reinforced tape was used to measure the mid-arm circumference. All measurements were made by one observer (Bester), who is a medical doctor and who received additional training before the survey commenced. All participants had undergone a physical examination as well as interviews on their nutrient intakes (Bester, Weich & Dannhauser, 1993) as part of the comprehensive survey (Bester, Weich & Albertyn, 1993). Conditions which could have influenced the measurements, such as oedema, fibrotic scars and skin diseases, were excluded during the physical examination.

Bone-free upper-arm muscle area (AMA). The following formulae (Frisancho, 1984) were used to calculate the bone-free upper-arm muscle area using the upper-arm circumference (UAC) and the triceps skinfold (TC):

Males $AMA\ (cm) = [\{UAC\ (cm) - \pi \times TC\ (cm)\}\ /4\pi\ ] - 10$
Females $AMA\ (cm) = [\{UAC\ (cm) - \pi \times TC\ (cm)\}\ /4\pi\ ] - 6{,}5$

Body mass index (BMI). The BMI was calculated as weight (kg)/height (m^2).

The results were analysed separately for males and females. The effect of age on all variables was determined by means of simple linear regression analyses.

Results

Table 1 shows the selected ten towns and the number of persons admitted to the study in each town. The study group consisted of the following ethnic divisions: South Sotho (50%), Tswana (16%), Xhosa (15%), Zulu (7%) and Northern Sotho (4,8%), while 7,2% belonged to other ethnic groups. The age distribution of the sample is shown in Figure 1. The average age was 73,5 years (73,3 (SD ±7,0) years for males and 73,7 (SD ±6,7) years for females). There were 146 persons aged 75 years or older (36,5%), which included 64 males (35,2%) and 82 females (37,6%).

All the participants lived in the community, were apparently healthy (they had no clinical conspicious disease), and had an adequate nutrient intake according to the 1989 United States' Recommended Daily Allowance (RDA) (Bester *et al.*, 1992, 1993).

Table 1
Selected towns and number of persons studied in each town

Town	Males	Females	Total
Bethlehem (Bohlokong)	12	14	26
Bloemfontein (Mangaung)	40	55	95
Botshabelo	53	60	113
Ficksberg	4	5	9
Frankfort (Namahadi)	2	3	5
Harrismith (42nd Hill)	6	6	12
Kroonstad (Maokeng)	23	27	50
Parys	8	9	17
Sasolburg (Zamdela)	9	10	19
Welkom (Thabaong)	25	29	54
TOTAL	182	218	400

Table 2 contains the descriptive statistics for the measurements as well as the calculated BMI and the corrected bone-free arm muscle areas (AMA) for males and females, respectively. The set of data from which percentiles were derived is shown in Table 3.

An interesting result which can be seen in both Tables 2 and 3 was that the women were heavier than the men, although they were shorter in stature. The bone-free upper-arm muscle area and all the skinfold measurements of the females were higher than those of the males. No inter-ethnic statistical differences were found between measurements within the sample.

Age was correlated with the anthropometrical measurements by means of simple linear regression and the results are shown in Table 4. The males' height declined significantly with increasing age, whilst the other measurements showed no significant correlation with age. All the values obtained from the females except for supra-iliac skinfold thickness showed significant correlation with age. Older women tended to be shorter and leaner than "younger" elderly women.

Figure 1
Age distribution of the sample of elderly blacks admitted to the study

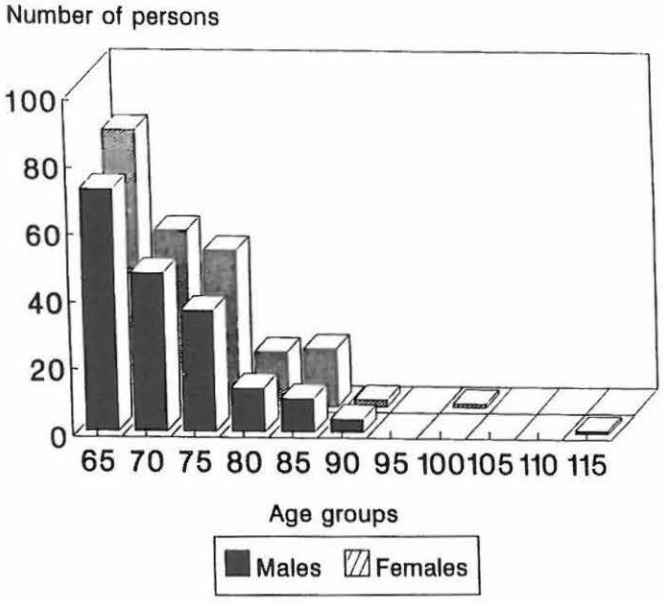

Table 2
Results of anthropometric measurements of the black elderly in the Orange Free State

	N	Mean	SD	Median	Range	Inter-quartile range
Males						
Age (years)	182	73,3	7,0	72	65-116	8
Height (cm)	180	163,3	7,3	164,5	143-182,5	10
Weight (kg)	180	59,6	12,5	57,2	32,5-108,8	16,6
Skinfolds						
Biceps (mm)	182	4,1	2,0	3,4	1,4-14	2,0
Triceps (mm)	182	7,8	3,8	7,0	1-28,8	4,8
Subscapular (mm)	182	10,0	5,0	8,9	0,4-32,4	6,4
Supra-iliac (mm)	182	7,5	4,5	6,2	2,4-35,5	5,0
Sum (mm)	182	29,4	13,1	25,6	8,8-93,0	16,8
Arm circum-ference (cm)	182	26,4	3,4	26,0	18,5-36	4,0
Body mass index (kg/m^2)	182	22,2	4,1	21,5	13,9-39,0	5,5
Bone-free upper AMA (cm^2)	181	36,2	10,6	34,9	14,9-69,8	12,3
Females						
Age (years)	217	73,7	6,7	73	65-104	8,0
Height (cm)	217	151,2	6,4	151	134-178	8,0
Weight (kg)	216	62,4	18,1	60,3	28-135	22,8
Skinfolds						
Biceps (mm)	216	7,7	4,5	6,6	1,4-23,8	5,1
Triceps (mm)	216	16,5	7,8	15,4	0,6-43,5	10,4
Subscapular (mm)	216	18,2	10,4	16,9	1,4-78	13,7
Super-iliac (mm)	216	13,3	6,7	12,6	1,4-38,8	8,0
Sum (mm)	216	55,7	25,7	52,6	8,6-133,4	35,8
Arm circum-ference (cm)	216	28,4	5,1	28,0	14,5-52,0	6,5
Body mass index (kg/m^2)	212	27,1	7,3	26,1	12,8-56,9	9,8
Bone-free upper AMA (cm^2)	216	37,4	13,2	34,9	9,8-110,4	14,8

Table 3
Percentiles of height, weight, biceps skinfold, triceps skinfold, subscapular skinfold, body mass index and bone-free arm muscle area for the black elderly in the Orange Free State

	Percentile						
	5	10	15	50	85	90	95
Males							
Height (cm)	151	154	155,5	164,5	171	172,3	175,3
Weight (kg)	42,5	45,7	46,8	57,2	72,2	77,2	80,4
Skinfolds							
Biceps (mm)	2,2	2,4	2,5	3,4	5,5	6,0	8,8
Triceps (mm)	3,7	4,2	4,6	7,1	11,0	12,6	15,3
Subscapular (mm)	4,8	5,2	5,6	8,9	14,8	15,8	19,4
Super-iliac (mm)	3,0	3,5	3,8	6,2	11,0	13,0	16,4
Body mass index (kg/m^2)	16,7	17,6	18,2	21,5	26,3	27,7	29,7
Bone-free upper AMA (cm^2)	32,2	34,9	35,9	44,9	57,1	61,5	67,1
Females							
Height (cm)	141	143	145	151	158	159,5	162
Weight (kg)	38,2	42,4	45,2	60,3	80,0	84,0	98,5
Skinfolds							
Biceps (mm)	2,5	3,0	3,6	6,6	12,0	14,4	17,6
Triceps (mm)	5,4	7,6	8,8	15,4	23,8	27,4	31,1
Subscapular (mm)	4,8	6,6	7,8	16,9	28,4	32,8	38,0
Supra-iliac (mm)	3,8	5,2	6,4	12,6	19,6	22,2	26,4
Body mass index (kg/m^2)	16,6	9,1	20,0	26,1	34,9	37,5	39,9
Bone-free upper AMA (cm^2)	25,2	29,1	33,0	41,4	55,7	60,3	65,7

Table 4
Simple linear regression of age against anthropometrical values of the black elderly

	Correlation coefficient	Intercept	Slope	R^2(%)	p
Males					
Height	-0,159	176,05	-0,17	2,52	0,033
Weight	0,012	58,02	0,02	0,01	0,872
Skinfolds					
Biceps	-0,060	5,31	-0,02	0,36	0,419
Triceps	-0,009	8,15	-0,005	0,01	0,908
Subscapular	0,033	8,29	0,023	0,11	0,662
Supra-iliac	0,071	4,16	0,046	0,51	0,338
Body mass index	0,098	17,89	0,058	0,96	0,190
Bone-free upper AMA	-0,00001	46,15	0,00002	0,00	1,000
Females					
Height	-0,256	169,55	-0,25	6,56	0,00015
Weight	-0,261	114,05	-0,70	6,78	0,00012
Skinfolds					+
Biceps	-0,212	18,13	-0,14	4,49	0,0017
Triceps	-0,202	33,95	-0,24	4,09	0,00282
Subscapular	-0,127	32,74	-0,20	1,61	0,06245
Supra-iliac	-0,299	35,29	-0,30	8,94	0,00001
Body mass index	-0,209	43,76	-0,23	4,37	0,00222
Bone-free upper AMA	0,177	63,07	-0,35	3,15	0,00896

Table 5 shows the body mass indices for other study populations (Bowen & Custer, 1984; Frisancho, 1984; Harris *et el.*, 1988; Simonopoulos & Van Itallie, 1984), together with the findings of this study and the "desirable" BMI. Three national health surveys (National Health Examination Survey (HES), 1960-62; National Health and Nutrition Examination Survey I (NHANES I) 1971-74; National Health and Nutrition Examination Survey II (NHANES II), 1976-80) have provided normative data on anthropometric indices in statistically valid samples of the United States population (Simonopoulos & Van Itallie, 1984). The concept of "desirable" body mass index was converted from the weight and height data of the 1959 Metropolitan Life Desirable Weight tables (Simonopoulos & Van Itallie, 1984). These values were associated with the lowest mortality (Simonopoulos & Van Itallie, 1984) and were therefore included in the table for comparison.

The BMI of the elderly black females corresponded to the highest values of the other studies (Bowen & Custer, 1984; Frisancho, 1984; Harris *et al.*, 1988; Simonopoulos & Van

Table 5
Mean body mass index (BMI) for men and women in various study populations

Study	BMI Males (kg/m^2)	BMI Females (kg/m^2)
National Health Examination Study (50 – 74 years) (USA)	25,5 (4,03)	26,7 (5,24)
NHANES 1 (50 – 74 years) (USA)	25,9 (4,36)	26,4 (5,69)
NHANES II (50 – 74 years) (USA)	26,2 (3,91)	26,5 (5,56)
Framington Heart Study (65-94 years) (USA)	26,3 (3,5)	27,5 (5,0)
This study (65+ years, Africans)	22,2 (4,1)	27,1 (7,3)
Desirable BMI*		
– Mean	22,0	21,5
– Range	20 – 25	19 – 26

* Data from the 1959 Metropolitan Life Desirable Weight Table. Values are the mean of the midpoint of persons with a medium frame, and the range of all heights and frames, for all ages.

Itallie, 1984), whilst the BMI of the elderly black males was lower than the figures of other studies and compared well with the desirable BMI.

When the mean weights and heights were compared with those obtained in studies in the Western world (Europe and the USA) (Bishop, 1984; Frisancho, 1984; Simonopoulos & Van Itallie, 1984) (see Table 6), it appeared that elderly black South Africans are shorter in stature.

Table 6
Mean weights and heights in elderly populations from other studies compared to this study

Study	Males		Females	
	Weight (kg)	Height (m)	Weight (kg)	Height (m)
HES (65-74 years)	71,1	1,70	65,3	1,56
NHANES 1 (50-74 years)	74,4	1,71	66,2	1,58
NHANES 11 (50-74 years)	74,8	1,71	66,7	1,58
This study (65+ years)	59,6	1,64	62,4	1,51

Discussion

In this study some anthropometrical measurements and indices of elderly black people in southern Africa were investigated. The sampling methods used, together with the high response rate, allowed some degree of confidence that the measurements obtained are representative of the sampled population. Although the anthropometry of the southern African black population had already been investigated as early as before 1910 (Brodie, 1855-1909, cited in Tobias, 1972a), the anthropometry of the elderly section of the population received little attention. Anthropometrical reference values are of importance when assessing the nutritional status of the elderly (body mass indices which are too low or too high indicate unhealthy nutrition); this study could therefore be of importance in this regard. Values derived from younger populations are not applicable to the elderly. Previous studies have shown a shortening of stature and a decrease in weight with ageing (Tobias, 1986). It is estimated that there is a 0,6 mm loss of stature for each year after the age of 30 years (Tobias, 1986). Body composition also changes with increasing age. Studies from potassium dilution and creatinine excretion revealed that there is a decline of about 6–8% per decade in lean body mass from middle age onwards, while the proportion of body fat either tends to increase or remain stable (Frisancho, 1984; Tobias, 1986).

From Table 1 it appeared that the females in the sample were shorter in stature than the males. This finding corresponded with all previous reports on other populations. However it was interesting to find that the average weight of the females in this study group was greater than that of the males. The skinfolds of the females were also much higher than those of the males. Previous findings which may be regarded as corresponding to some extent are those obtained in 1964 amongst a sample of Zulus (Tobias, 1972 a,b). While Zulu males had skinfolds with low mean values in comparison with white males, the Zulu females showed skinfolds which did not significantly differ from those in white females (Tobias, 1972 a,b). The findings in the latter study may also imply that the females were more obese than the males. However it would be interesting to see whether black females are heavier than black males in other regions of Africa. Although the females in this study were heavier than the males, it seemed from the other anthropometrical indices (skinfolds and bone-free upper AMA) that this excess weight was mainly fatty tissue.

According to the simple linear regressions in Table 3 only height decreases significantly with increasing age in the case of males, although all values, except for the subscapular skinfold, were found to diminish with increasing age. These results from regression analyses should however be interpreted with caution. This study group had an age distribution that was skewed with fewer participants in the higher age categories (see Figure 1). This situation reduces the power of the regression analyses. Further, the study used a cross-sectional sample of elderly people; changes relating to advancing age should rather be addressed by means of longitudinal studies. Another important factor is the processes operating on a given birth cohort. Any group of elderly subjects represents only the surviving segment of a given population.

Elderly southern African blacks seem to be shorter in stature than their elderly counterparts in industrialized countries (see Table 5). When compared to data presented by Frisancho (1984) regarding medium-framed US citizens, it appears that the females in this study had more or less the same weight as the elderly females in industrialized countries. However the males appeared to be much leaner with a much lower BMI. Several factors may be responsible for this outcome. First, genetic differences may account for some of the dissimilarities. Previous studies in southern Africa showed that interracial differences exist amongst blacks in respect of stature (Tobias, 1975). This study did not show significant differences. However groups other than Sotho-speaking people were small in number. Blacks in the northern parts of South Africa have been found to be taller than those in the central parts of the country (Tobias, 1975). It may be assumed that the living conditions of these groups were more or less the same and that differences in stature may possibly be of genetic origin. Secular trends of stature could also have influenced these differences. Evidence exists which showed a positive secular trend over the last century, up to about the mid-1960s for nations in industrialized countries (Tobias, 1985). Nations in developing countries with less favourable living conditions showed no secular trend or even negative secular trends (Tobias, 1985). In this regard it would be interesting to see what will happen with future black elderly cohorts in view of the expected improvement in socio-economic conditions.

Whatever the reason for the differences may be, it was clear from the study that there are differences in stature when black elderly South Africans are compared to other elderly populations. This situation required us to examine other indices of body composition as well. We compared the triceps skinfold, the subscapular skinfold and the bone-free upper-arm muscle area with National Health and Nutrition Examination Surveys in the United States (Frisancho, 1984). The percentiles of the triceps and subscapular skinfolds were lower than those mentioned by Frisancho, but the 50th percentile of the AMA fell between the 50th percentile of the medium and large frame sizes noted by Frisancho. This finding could suggest that not only stature and weight but also body composition differ between populations of the developing world and developed countries.

Conclusion

This article has presented anthropometric data regarding the black elderly population derived from an epidemiological study of a subpopulation in the Orange Free State. It appeared that members of this population are shorter in stature and that the males are leaner than those in comparable populations in industrialized countries. It is therefore important to use reference values during clinical and nutritional evaluation which

are derived from the same population. For the same reason this reference value should not be generalized to elderly blacks outside the Orange Free State.

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