STEM AND STANDING HEIGHTS IN BANTU AND WHITE SOUTH AFRICANS: THEIR SIGNIFICANCE IN RELATION TO PULMONARY FUNCTION VALUES*

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SUMMARY

Sitting and standing heights have been recorded for Bantu and Whites, males and females. It was found that Bantu males and females have relatively longer lower extremities than White South African males and females. Anthropometric differences account for only about 15% of the actual observed difference in spirometrically determined lung volumes of Bantu and Whites in the groups observed.

It has been suggested that the differences in pulmonary function values for Bantu as compared with Whites could be accounted for by a difference in body proportions in these groups: people of Negroid extraction have relatively longer extremities.[1,2] This difference has not been established for the racial groups in South Africa. Since standing height is used as an important correlation in the prediction equation and particularly since the use of the stem height (sitting height) has been suggested to provide a more accurate criterion than standing height in prediction formulae,[3] it seemed important to determine (*i*) whether any racial differences in body proportions did in fact exist and (*ii*), whether such differences could account for the differences observed in pulmonary function values.

METHOD

Measurements were made of stem (sitting) and standing height of 186 Bantu men, 152 White men, 165 Bantu women and 151 White women, a total of 654 subjects. The Bantu men were taken at random from patients in medical wards, Bantu women at random from the hospital staff, White men at random from a group of White miners and White women from the hospital staff.

Standing height was measured with subjects standing barefoot against a wall. Stem height was measured with all subjects using the same chair which had a horizontal seat, and to which a vertical bar was attached. All measurements were recorded in centimetres and compared with the same measurements for a group of Welsh coalminers taken from a report by Gilson *et al.*[4]

RESULTS

The distribution of the samples according to age is shown in Tables I - VI. Mean stem heights and standing heights, and the mean of the ratio stem to standing height recorded as a percentage, together with the standard deviation, standard error of the mean, maximum and minimum values and the range are recorded for each 10-year age-group. Although age was recorded, this variable did not correlate significantly with the value observed and was therefore discarded in the prediction equations for stem height from

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TABLE I. MEAN STEM HEIGHTS AND STANDING HEIGHTS (IN CM) FOR 152 WHITE MEN

Age-group	*No.*	*Mean*	*SD*	*SE*	*Max.*	*Min.*	*Range*
Stem height							
20 - 29	49	90·39	3·42	0·49	97·0	82·0	15·0
30 - 39	34	88·79	3·02	0·52	94·0	82·0	12·0
40 - 49	30	89·40	2·90	0·53	95·0	80·0	15·0
50 - 59	39	91·08	3·78	0·60	98·0	80·0	18·0
Standing height							
20 - 29	49	174·04	6·33	0·90	191·0	165·0	26·0
30 - 39	34	173·23	5·09	0·87	180·0	160·0	20·0
40 - 49	30	173·23	3·84	0·70	181·0	163·0	18·0
50 - 59	39	178·05	5·73	0·92	190·0	165·0	25·0
Ratio stem height/standing height (%)							
20 - 29	49	51·95	1·55	0·22	55·29	46·07	9·22
30 - 39	34	51·29	1·10	0·19	53·18	48·52	4·66
40 - 49	30	51·61	1·46	0·27	54·91	47·34	7·57
50 - 59	39	51·35	1·35	0·22	53·14	47·54	5·60

SD = standard deviation of mean values.
SE = standard error of mean values.

TABLE II. MEAN STEM HEIGHTS AND STANDING HEIGHTS (IN CM) FOR 186 BANTU MEN

Age-group	*No.*	*Mean*	*SD*	*SE*	*Max.*	*Min.*	*Range*
Stem height							
20 - 29	68	83·78	3·08	0·37	91·0	76·0	15·0
30 - 39	52	83·50	2·97	0·41	90·0	77·0	13·0
40 - 49	35	83·89	3·22	0·54	90·0	77·0	13·0
50 - 59	31	84·06	3·39	0·61	90·0	77·0	13·0
Standing height							
20 - 29	68	168·10	6·10	0·74	185·0	155·0	30·0
30 - 39	52	165·90	5·67	0·79	179·0	155·0	24·0
40 - 49	35	167·11	5·73	0·99	177·0	156·0	21·0
50 - 59	31	166·10	6·01	1·08	178·0	149·0	29·0
Ratio stem height/standing height (%)							
20 - 29	68	49·85	1·56	0·19	56·25	45·35	10·90
30 - 39	52	50·38	1·91	0·27	54·66	47·31	7·35
40 - 49	35	50·22	1·65	0·28	53·13	47·09	6·04
50 - 59	31	50·62	1·24	0·22	53·02	47·31	5·71

SD = standard deviation of mean values.
SE = standard error of mean values.

TABLE III. MEAN STEM HEIGHTS AND STANDING HEIGHTS (IN CM) FOR 40 WELSHMEN

Age-group	*No.*	*Mean*	*SD*	*SE*	*Max.*	*Min.*	*Range*
Stem height							
20 - 29	10	90·80	2·74	0·87	95·0	87·0	8·0
30 - 39	10	91·40	3·60	1·14	97·0	86·0	11·0
40 - 49	10	90·30	3·59	1·14	98·0	86·0	12·0
50 - 59	10	89·70	3·37	1·06	94·0	84·0	10·0
Standing height							
20 - 29	10	172·80	5·88	1·86	181·0	164·0	17·0
30 - 39	10	173·40	7·60	2·40	184·0	163·0	21·0
40 - 49	10	171·30	6·46	2·04	181·0	160·0	21·0
50 - 59	10	169·60	7·78	2·46	177·0	158·0	19·0
Ratio stem height/standing height (%)							
20 - 29	10	52·56	1·31	0·39	54·60	51·11	3·49
30 - 39	10	52·73	0·89	0·28	54·12	51·46	2·66
40 - 49	10	52·72	1·21	0·38	55·00	51·19	3·81
50 - 59	10	52·91	6·84	0·26	54·43	51·41	3·02

SD = standard deviation of mean values.
SE = standard error of mean values.

TABLE IV. MEAN STEM HEIGHTS AND STANDING HEIGHTS (IN CM) FOR 151 WHITE WOMEN

Age-group	No.	Mean	SD	SE	Max.	Min.	Range
Stem height							
20 - 29	49	85·98	3·25	0·46	93·00	74·00	19·00
30 - 39	34	87·26	4·68	0·80	99·00	71·00	28·00
40 - 49	30	86·40	1·96	0·36	90·00	82·00	8·00
50 - 59	38	86·87	2·99	0·48	93·00	78·00	15·00
Standing height							
20 - 29	49	165·59	6·51	0·93	185·00	152·00	33·00
30 - 39	34	165·26	6·91	1·18	177·00	150·00	27·00
40 - 49	30	164·60	5·36	0·98	178·00	153·00	25·00
50 - 59	38	165·97	5·97	0·96	175·00	150·00	25·00
Ratio stem height/standing height (%)							
20 - 29	49	52·15	2·85	0·93	55·41	47·13	8·28
30 - 39	34	52·84	1·97	0·34	56·25	45·00	11·25
40 - 49	30	52·52	1·13	0·21	55·41	49·44	5·97
50 - 59	38	52·34	2·55	0·41	54·44	47·27	7·17

SD = standard deviation of mean values.
SE = standard error of mean values.

TABLE V. MEAN STEM HEIGHTS AND STANDING HEIGHTS (IN CM) FOR 165 BANTU WOMEN

Age-group	No.	Mean	SD	SE	Max.	Min.	Range
Stem height							
20 - 29	50	80·32	2·86	0·40	88·0	75·0	13·0
30 - 39	42	81·64	2·77	0·43	88·0	76·0	12·0
40 - 49	41	81·71	2·81	0·44	88·0	77·0	11·0
50 - 59	32	81·97	2·25	0·44	87·0	76·0	11·0
Standing height							
20 - 29	50	157·60	5·73	0·81	170·0	146·0	24·0
30 - 39	42	159·45	5·67	0·87	173·0	149·0	24·0
40 - 49	41	159·90	4·95	0·77	171·0	150·0	21·0
50 - 59	32	159·34	4·51	0·80	167·0	151·0	16·0
Ratio stem height/standing height (%)							
20 - 29	50	51·11	1·61	0·23	54·14	47·90	7·14
30 - 39	42	51·24	1·87	0·29	56·29	47·02	9·27
40 - 49	41	51·11	1·77	0·28	56·29	46·71	9·58
50 - 59	32	51·46	1·70	0·30	56·29	48·50	7·79

SD = standard deviation of mean values.
SE = standard error of mean values.

TABLE VI. MEAN STEM HEIGHTS AND STANDING HEIGHTS (IN CM) FOR TOTAL OF SAMPLE GROUPS

Sample group	No.	Mean	SD	SE	Max.	Min.	Range
Stem height							
White men	152	90·01	3·42	0·28	98·0	80·0	18·0
Bantu men	186	83·77	3·11	0·23	91·0	76·0	15·0
Welsh men	40	90·55	3·27	0·52	98·0	84·0	14·0
White women	151	86·58	3·37	0·27	99·0	80·0	18·0
Bantu women	165	81·32	2·82	0·22	88·0	75·0	13·0
Standing height							
White men	152	174·73	5·78	0·47	191·0	160·0	31·0
Bantu men	186	166·97	5·93	0·43	185·0	149·0	36·0
Welsh men	40	171·77	6·87	1·08	184·0	158·0	26·0
White women	151	165·42	6·21	0·50	185·0	150·0	35·0
Bantu women	165	158·98	5·34	0·42	173·0	146·0	27·0
Ratio stem/standing height (%)							
White men	152	51·58	1·43	0·12	55·29	46·07	9·22
Bantu men	186	50·14	1·67	0·12	56·25	47·09	9·16
Welsh men	40	52·73	1·02	0·16	55·00	51·11	3·89
White women	151	52·36	2·43	0·19	66·44	35·41	29·03
Bantu women	165	51·21	1·73	0·42	58·28	46·71	11·57

SD = standard deviation of mean values.
SE = standard error of mean values.

standing height and vice versa. The regression equations are as follows:

White men
Standing height $= 69{\cdot}924 + 1{\cdot}1643 \times$ stem height
Stem height $= 18{\cdot}97 + 0{\cdot}4066 \times$ standing height
Bantu men
Standing height $= 56{\cdot}0322 + 1{\cdot}3243 \times$ stem height
Stem height $= 22{\cdot}94 + 0{\cdot}3643 \times$ standing height
Welshmen
Standing height $= 5{\cdot}3766 + 1{\cdot}8376 \times$ stem height
Stem height $= 18{\cdot}8173 + 0{\cdot}4176 \times$ standing height
White women
Standing height $= 68{\cdot}565 + 1{\cdot}1187 \times$ stem height
Stem height $= 31{\cdot}97 + 0{\cdot}3301 \times$ standing height
Bantu women
Standing height $= 72{\cdot}102 + 1{\cdot}0683 \times$ stem height
Stem height $= 34{\cdot}099 + 0{\cdot}2970 \times$ standing height

DISCUSSION

Aslett *et al.*[3] measured a closer correlation of the subdivision of lung volumes with sitting or stem height than with standing height. One of us (L.D.E.), in a previous publication on clinical spirometry in normal Bantu,[5] noted that total lung capacity and all the lung compartments in Bantu men and women were significantly smaller than in Whites, but that the ratio of residual volume to total lung capacity in Bantu subjects did not differ significantly from that in Whites.

Forced expiratory volumes in Bantu were also significantly smaller than in Whites, but the percentage expired did not differ significantly. Also maximum voluntary ventilation and maximum expiratory flow-rate were smaller in the Bantu, but results of single-breath nitrogen elimination tests in Bantu subjects did not differ significantly from those in Whites.

Thus it was concluded that erroneous conclusions could be reached unless prediction equations for lung function tests for a given ethnic group are derived from studies on the same group. Smiley and Augentine[1] postulated that the observed smaller vital capacity in Negroes could in part be ascribed to the differences in body build: Negroes having shorter trunk lengths and longer limbs than Whites. The report of the National Center for Health Statistics of the United States[2] states that 'Negroids tend to have longer extremities relative to their stature than Caucasians'. Smaller lung volume values have also been found in Indians and in New Zealanders of Polynesian stock.[6] No reasons were advanced for these differences.

We were unable to find any comprehensive anthropometric measurements in Bantu subjects. The only available report was that by Flemming *et al.*,[7] which did not confirm this difference in body proportions, but their groups were too small (17 Bantu men and 21 Bantu women) to justify any general conclusion. From Table VI it can be seen that the South African Bantu has a slightly lower ratio of stem height to standing height than the White South African, whose ratio in turn is lower than that of a group of Welshmen. Thus the lower extremities in the Bantu both male and female, are relatively longer than those of the White male and female, although standing height and stem height is shorter.

In order to evaluate the significance of these differences in body build regression equations for both stem or standing height were computed (see above), whereby sitting height could be used as a correlation in the prediction formulae for lung functions. Taking a 'standard' White male aged 30 years, with a standing height of 167 cm, whose stem height would be 87 cm, as an example, then the following is observed: the predicted normal mean vital capacity for this man would be 3·45 litres according to 'Bantu values',[1] and 4·7 litres according to 'White values'.[8] There is thus a predicted difference of 1·25 litres.

If stem or sitting height of 87 cm is first used to calculate standing height, and if vital capacity is then predicted from standing height, the following values will be derived: the Bantu male would be 171 cm tall, and would have a vital capacity of 3·6 litres, and the White male would be 167 cm tall and would have a vital capacity of 4·7 litres. Thus the difference in vital capacity is only reduced to 1·1 litres.

It may, therefore, be concluded that anthropomorphic differences in this example account for only a small proportion of the observed difference in vital capacity. Differences of the same order can be found for other divisions of total lung capacity. It is interesting to note that this disproportion is much more marked if the bodily proportions of Gilson's Welsh miners are substituted for those of the South African Whites.

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