# Anthropometric norms in the elderly

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1. Anthropometric indices are presented for representative samples of elderly people in South Wales, based on over 1500 subjects seen during community surveys.

2. Body mass index declined with age after 70 years in both men and women. Estimates of fat and muscle volume based on upper arm measurements also showed a decline with age, which was particularly steep for triceps skinfold thickness in women.

3. These indices are in general similar to results that have been reported from other surveys within the UK; they suggest that Welsh old people have less fat and muscle than elderly Americans.

Anthropometric percentiles have long been used in the diagnosis and surveillance of malnutrition in children. During recent years various anthropometric indices have been published for adults, including results from large surveys in the USA (Bishop *et al.* 1981; Frisancho, 1981). In general, the information available for the elderly has been rather sparse, especially for persons aged over 75 years. Information has been collected from over 1500 old people in South Wales during community surveys, and these findings are presented here in the form of percentiles to provide a frame of reference for elderly people in Britain.

## SUBJECTS AND METHODS

The surveys were conducted in three areas of South Wales, two of which have an industrial history of coal mining. Names and addresses of the subjects were obtained from the lists of local general practitioners. In the largest of the three surveys, the sample was stratified by age to provide more subjects over 75 years of age. This survey also included residents of old people's homes (4%) and long-stay hospital wards (3%) whereas, in the other two areas, only people living at home were included. The values of the sampling ratios and other details of the surveys have already been published (Burr *et al.* 1974, 1975, 1979).

The heights and weights of the subjects were measured in indoor clothes without shoes. In the largest of the three surveys, the triceps skinfold thickness was measured with Harpenden callipers over the left triceps muscle midway between the acromion and the olecranon process; three measurements were made and the median reading taken. The mid-arm circumference was measured twice at the same point and the mean taken as the true value. The arm measurements were all made by the same observer (M.L.B.).

Body mass index (Quetelet index) was calculated as weight (kg) divided by the square of the height ($m^2$). The arm muscle area ($mm^2$) and arm muscle circumference (mm) were calculated using the following formulas derived from Gurney & Jelliffe (1973):

$$\text{arm muscle circumference} = \text{arm circumference} - \pi\,(\text{triceps skinfold thickness})$$

$$\text{arm muscle area} = \frac{(\text{arm muscle circumference})^2}{4\pi}.$$

These formulas assume that the upper arm is cylindrical, and they ignore the contribution to arm volume made by the humerus. Nevertheless, the indices derived from them seem to be serviceable and are widely used.



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Percentiles within each age group were constructed for both sexes, first, using the actual number of subjects at each percentile and, second, using the means (with SD) of the indices.

## RESULTS

Response rates in the three areas were 85·2%, 93·9% and 86·2%; other details have already been published (Burr *et al.* 1982*b*). No significant difference was found between the mean body mass indices for the three areas, after controlling for age, for either sex. The results for the three areas were, therefore, combined. The distribution of the skinfold thicknesses was distinctly skewed but, after logarithmic transformation, it did not differ significantly from the Normal (Gaussian) distribution in either sex or in any age/sex group. The distributions of the other indices were not significantly different from the Normal distribution. The percentiles derived from the means (with SD), using transformed results for the skinfold thicknesses, are those presented here; they agreed closely with the percentiles obtained directly from the actual numbers.

Table 1 shows the percentiles for body mass index; there is a tendency for the index to decline with age after 70 years. Table 2 shows the percentiles for mid-arm circumference, which tend to decline with age over the whole age span, especially in the women. Percentiles for skinfold thickness are shown in Table 3, and the decline with age is particularly marked in the women. Tables 4 and 5 present percentiles for arm muscle area and arm muscle circumference respectively. Both these indices decline steadily with age and at approximately the same rate in men and women. Tables 2–5 contain less subjects than Table 1, since height and weight were measured in all three surveys whereas the arm measurements were taken in only one.

## DISCUSSION

The results of the present experiment are given in order to provide standards of reference with which values obtained in individuals can be compared. Published anthropometric norms tend to include few subjects over the age of 75, although there are known to be substantial changes in these indices with age, and it seems reasonable to compare individual old people with their contemporaries rather than with younger people in assessing their nutritional status. Percentiles, rather than mean values, are probably the most suitable form in which anthropometric norms can be used (Gray & Gray, 1979).

The decline in body mass index with age seems to be due to a longitudinal change with advancing years rather than a survival effect as obese people die. Indeed, mortality is associated with leanness rather than with obesity in old people (Burr *et al.* 1982*a*). The actual loss of weight experienced by individuals with age is greater than the cross-sectional decline in body mass index might suggest, first, because this decline occurs despite the selective survival of heavier old people and, second, because body mass index is adjusted for height, which also declines in old age.

When examining differences in body size there are good reasons for studying estimates of fat and muscle volume separately, and this can be done by means of arm measurements. The indices of muscle size decline with age to an approximately similar extent in men and women, suggesting a progressive loss of muscle bulk in both sexes. The decline in these indices probably underestimates the actual changes which occur (Frisancho, 1981).

The decline in skinfold thickness suggests that fat is also lost with advancing age, in contrast to the report of McEvoy & James (1982) which was based on a smaller number of highly selected subjects. This decline was especially marked among the women, suggesting that they are more liable to lose fat than are the men. This impression may be misleading, however, as triceps skinfold thickness seems to be a better estimate of fat stores in women than it is in men (Mitchell & Lipschitz, 1982).

Clearly these norms must be considered in relation to the population from which they were derived. The high response rates allow some degree of confidence that the figures

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Table 1. *Percentiles for body mass index ($kg/m^2$)*

| Age group (years) | No. | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
| Men | | | | | | | | |
| 65–69 | 46 | 18·1 | 19·4 | 21·8 | 24·3 | 26·9 | 29·2 | 30·5 |
| 70–74 | 171 | 18·9 | 20·2 | 22·6 | 25·1 | 27·7 | 30·0 | 31·3 |
| 75–79 | 188 | 17·5 | 18·9 | 21·3 | 23·9 | 26·5 | 28·9 | 30·3 |
| 80–84 | 87 | 18·1 | 19·4 | 21·4 | 23·7 | 26·0 | 28·1 | 29·3 |
| 85+ | 41 | 17·9 | 19·0 | 21·0 | 23·1 | 25·2 | 27·2 | 28·4 |
| Women | | | | | | | | |
| 65–69 | 53 | 17·2 | 19·2 | 22·7 | 26·5 | 30·3 | 33·8 | 35·9 |
| 70–74 | 250 | 18·4 | 20·2 | 23·1 | 26·3 | 29·5 | 32·4 | 34·2 |
| 75–79 | 329 | 18·1 | 19·8 | 22·8 | 26·1 | 29·4 | 32·4 | 34·1 |
| 80–84 | 200 | 17·1 | 19·0 | 22·1 | 25·5 | 28·9 | 32·0 | 33·9 |
| 85+ | 88 | 16·7 | 18·2 | 20·8 | 23·6 | 26·4 | 29·0 | 30·5 |

Table 2. *Percentiles for mid-arm circumference (mm)*

| Age group (years) | No. | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
| Men | | | | | | | | |
| 65–69 | 47 | 206 | 218 | 238 | 260 | 282 | 302 | 314 |
| 70–74 | 45 | 209 | 219 | 236 | 255 | 274 | 291 | 301 |
| 75–79 | 119 | 197 | 208 | 226 | 245 | 264 | 282 | 293 |
| 80–84 | 56 | 193 | 202 | 219 | 237 | 255 | 272 | 281 |
| 85+ | 31 | 189 | 198 | 213 | 230 | 247 | 262 | 271 |
| Women | | | | | | | | |
| 65–69 | 54 | 212 | 223 | 243 | 264 | 285 | 305 | 317 |
| 70–74 | 47 | 201 | 213 | 233 | 255 | 277 | 297 | 309 |
| 75–79 | 219 | 193 | 206 | 226 | 249 | 272 | 293 | 305 |
| 80–84 | 131 | 179 | 192 | 212 | 235 | 258 | 279 | 291 |
| 85+ | 75 | 164 | 176 | 198 | 221 | 245 | 266 | 278 |

Table 3. *Percentiles for triceps skinfold thickness (mm)*

| Age group (years) | No. | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
| Men | | | | | | | | |
| 65–69 | 47 | 3·6 | 4·3 | 5·9 | 8·1 | 11·3 | 15·2 | 18·2 |
| 70–74 | 45 | 3·7 | 4·3 | 5·8 | 8·0 | 10·9 | 14·6 | 17·3 |
| 75–79 | 119 | 3·6 | 4·2 | 5·3 | 7·0 | 9·2 | 11·7 | 13·6 |
| 80–84 | 56 | 3·5 | 4·1 | 5·1 | 6·6 | 8·5 | 10·7 | 12·3 |
| 85+ | 31 | 3·4 | 3·9 | 5·0 | 6·5 | 8·4 | 10·6 | 12·2 |
| Women | | | | | | | | |
| 65–69 | 54 | 9·9 | 11·3 | 14·1 | 18·0 | 22·9 | 28·5 | 32·5 |
| 70–74 | 47 | 8·2 | 9·5 | 12·1 | 15·9 | 20·9 | 26·8 | 31·1 |
| 75–79 | 219 | 7·5 | 8·6 | 11·1 | 14·6 | 19·1 | 24·5 | 28·4 |
| 80–84 | 131 | 6·2 | 7·2 | 9·5 | 12·7 | 17·1 | 22·4 | 26·2 |
| 85+ | 75 | 6·0 | 7·0 | 8·8 | 11·5 | 14·9 | 19·0 | 21·8 |



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Table 4. *Percentiles for arm muscle area (mm²)*

| Age group (years) | No. | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
| Men | | | | | | | | |
| 65–69 | 47 | 2680 | 3040 | 3650 | 4320 | 4990 | 5420 | 5960 |
| 70–74 | 45 | 2710 | 3030 | 3560 | 4140 | 4720 | 5250 | 5570 |
| 75–79 | 119 | 2530 | 2840 | 3360 | 3940 | 4520 | 5040 | 5350 |
| 80–84 | 56 | 2370 | 2660 | 3160 | 3710 | 4260 | 4760 | 5060 |
| 85+ | 31 | 2270 | 2540 | 2980 | 3470 | 3960 | 4400 | 4670 |
| Women | | | | | | | | |
| 65–69 | 54 | 2020 | 2310 | 2810 | 3350 | 3890 | 4390 | 4680 |
| 70–74 | 47 | 1840 | 2160 | 2690 | 3270 | 3850 | 4380 | 4700 |
| 75–79 | 219 | 1970 | 2240 | 2710 | 3230 | 3750 | 4220 | 4490 |
| 80–84 | 131 | 1720 | 2000 | 2460 | 2970 | 3480 | 3940 | 4220 |
| 85+ | 75 | 1430 | 1700 | 2170 | 2690 | 3210 | 3680 | 3950 |

Table 5. *Percentiles for arm muscle circumference (mm)*

| Age group (years) | No. | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5th | 10th | 25th | 50th | 75th | 90th | 95th |
| Men | | | | | | | | |
| 65–69 | 47 | 187 | 196 | 213 | 231 | 249 | 266 | 275 |
| 70–74 | 45 | 184 | 194 | 209 | 227 | 245 | 260 | 270 |
| 75–79 | 119 | 182 | 190 | 205 | 221 | 237 | 252 | 260 |
| 80–84 | 56 | 176 | 184 | 199 | 215 | 231 | 246 | 254 |
| 85+ | 31 | 172 | 180 | 193 | 208 | 223 | 236 | 244 |
| Women | | | | | | | | |
| 65–69 | 54 | 163 | 172 | 187 | 204 | 221 | 236 | 245 |
| 70–74 | 47 | 158 | 168 | 184 | 201 | 218 | 234 | 244 |
| 75–79 | 219 | 161 | 169 | 184 | 200 | 216 | 231 | 239 |
| 80–84 | 131 | 151 | 160 | 175 | 192 | 209 | 224 | 233 |
| 85+ | 75 | 141 | 150 | 165 | 182 | 199 | 214 | 223 |

represent the population being sampled, and the absence of any significant difference in body mass index between the three areas suggests that the findings can, at least, be extrapolated to South Wales. Results obtained from other geographical areas, however, may well be different from those presented here. The indices of body mass are similar to those reported from various parts of Britain in a survey by the Committee on Medical Aspects of Food Policy (1979). The arm circumference figures in that survey are also similar to our results although the arm muscle areas tend to be marginally higher in our survey. A small survey in Northern Ireland showed similar skinfold thickness values; mean triceps skinfold thickness tends to be a little higher in elderly Americans and a little lower in elderly Canadians compared with old people in South Wales (Vir & Love, 1980; U.S. Department of Health, Education and Welfare, 1970; Burr *et al.* 1982*b*). Americans aged 65–74 years seem also to have a greater muscle mass as represented by arm muscle area and arm muscle circumference (Bishop *et al.* 1981; Frisancho, 1981). This cannot be explained by the exclusion of institutionalized people from the American figures and their inclusion in ours

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since, in this age group, only three women lived in residential homes and no subject was in a long-stay hospital ward. Geographical differences must be borne in mind when individuals are compared against published norms.

## REFERENCES

Bishop, C. W., Bowen, D. E. & Ritchley, S. J. (1981). *American Journal of Clinical Nutrition* **34**, 2530–2539.
Burr, M. L., Charles, T. J., Roy, K. & Seaton, A. (1979). *British Medical Journal* **1**, 1041–1044.
Burr, M. L., Elwood, P. C., Hole, D. J., Hurley, R. J. & Hughes, R. E. (1974). *American Journal of Clinical Nutrition* **27**, 144–151.
Burr, M. L., Lennings, C. I. & Milbank, J. E. (1982*a*). *Age and Ageing* **11**, 249–255.
Burr, M. L., Milbank, J. E. & Gibbs, D. (1982*b*). *Age and Ageing* **11**, 89–96.
Burr, M. L., St Leger, A. S., Westlake, C. A. & Davies, H. E. F. (1975). *Age and Ageing* **4**, 148–151.
Committee on Medical Aspects of Food Policy (1979). *Nutrition and Health in Old Age*. London: H.M. Stationery Office.
Frisancho, A. R. (1981). *American Journal of Clinical Nutrition* **34**, 2540–2545.
Gray, G. E. & Gray, L. K. (1979). *Journal of Parenteral and Enteral Nutrition* **3**, 366–368.
Gurney, J. M. & Jelliffe, D. B. (1973). *American Journal of Clinical Nutrition* **26**, 912–915.
McEvoy, A. W. & James, O. F. W. (1982). *Age and Ageing* **11**, 97–100.
Mitchell, C. O. & Lipschitz, D. A. (1982). *American Journal of Clinical Nutrition* **36**, 340–349.
U.S. Department of Health, Education and Welfare (1970). *Vital and Health Statistics: Data from the National Health Survey*. Public Health Service publication no. 1000, series 11, no. 35.
Vir, S. C. & Love, A. H. G. (1980). *Gerontology* **26**, 1–8.

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