Weight, skinfolds and circumference characteristics of poor elderly people in Mumbai, India

MC Manandhar[1], PS Anklesaria[2], and SJ Ismail[1]

[1] *Public Health Nutrition Unit, Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK*
[2] *Biomedical Gerontology Centre of HelpAge India, Department of Pharmacology, Seth GS Medical College and King Edward VII Memorial Hospital, Parel, Mumbai 400 012, India*

This paper describes the anthropometric characteristics of 1,335 (males 545, females 790) people of low socio-economic classes aged 50-97 years (mean age 60 years) living in slums and tenement blocks around a major teaching hospital in central Mumbai (Bombay). Descriptive statistics for weight, mid-upper arm and calf circumferences, and biceps, triceps, subscapular and suprailiac skinfolds are presented. Subjects were much lighter, thinner and had smaller circumferences than their age- and sex- matched American counterparts but were similar to nationally representative Indian slum groups, as well as other Asian groups. Men were significantly heavier than women and had larger circumferences whereas women had significantly fatter skinfoldss. Age was significantly but non-linearly related to all variables in women but only to mid-upper arm and calf circumferences in men : there was a marked step effect with the age cut-off 70 years. Reliability for all measurements was high ($R > 0.95$), with technical errors of measurement highest for skinfolds, especially the suprailiac. The overall prevalence of oedema was 2.8%. In the whole sample, men were significantly older than women, probably because men are more likely to be out working than women, especially below 65 years old. A good participation rate was achieved (78%), with women more likely to participate than men. Almost half of the non-participancy can be attributed to work-related activity, particularly in men. Discussion focuses on practical issues of taking anthropometric measurements in elderly people living in the community, reliability, and non-participant bias.

Key words: Anthropometry, India, Mumbai, elderly, urban slums, poverty, weight, height, skinfolds, circumference, malnutrition, oedema

Introduction

Ageing and urbanisation phenomena in India are changing the course of national health and nutrition policies. Elderly people living in the cities must now rank among India's priority concerns[1]. As part of the process of developing new programmes to meet the needs of the urban poor, malnutrition and impaired functional ability amongst urban elderly people living in poor socio-economic conditions must receive attention and the gaps in knowledge filled without delay.

This paper presents the characteristics of weight, mid-upper arm and maximal calf circumferences, and four skinfold thicknesses, from a study of low-income elderly people living in urban India. Reflecting both lean and fat tissues, the measurement of weight is a crude measure of nutritional status but unusually low weight or rapid changes in weight are of interest, and weight is an essential component for the derivation of body mass index (BMI). A decrease in mid-upper arm circumference (MUAC) reflects recent weight loss of both adipose and lean tissue, and in combination with arm skinfolds, can be used to calculate other indices of muscle mass depletion which predict morbidity and mortality[2]. Calf circumference is considered the most sensitive measurement of muscle mass in the elderly[3]. Skinfolds thicknesses, particularly triceps and subscapular, provide an estimate of total body fat in elderly people and are in common clinical use[4].

This study forms part of a collaborative partnership between the Public Health Nutrition Unit, London School of Hygiene and Tropical Medicine (LSHTM) and HelpAge International, a non-governmental organisation committed to improving the lives of elderly people worldwide. Fieldwork took place in Mumbai between March and December 1993, and operated under the umbrella of an existing programme: the Biomedical Gerontology Centre of HelpAge India (BGCHI), based within the Department of Pharmacology of the Seth GS Medical College and King Edward VII Memorial (KEM) Hospital. The BGCHI was established in 1991 as a service-orientated research centre to assess the health status of poor elderly people living around the hospital, to diagnose, treat and monitor chronic and acute health problems. Ethics Committees of both the LSHTM and the KEM Hospital approved the nutrition research. The Central Drug Research Institute of India, a government body, from which the BGCHI had already received official sanction and under which its main scientific and managerial staff were employed, also gave its approval.

Correspondence address: MC Manandhar, Public Health Nutrition Unit, Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, 2 Taviton Street, London WCIH OBT, UK
Tel: +44 171 927 2131; Fax: +44 171 383 5859
e-mail: maryman@mos.com.np; M.Manandhar@lshtm.ac.uk

Study site and population

In 1991 the number of people over 60 years old in India stood at about 55 million, or about 6.5% of the total population of 844 million[5]. This is forecast to rise to 150 million (12%) by 2025. In 1991, the population of Mumbai, India's foremost industrial and commercial centre, was approximately ten million[6]. The 1981 Census of India reported the proportion of over 50 year olds in Greater Mumbai as approximately 9% of the total population, large numbers of whom are living in slums and government-owned tenement blocks where most of the projected rise in the city's population is likely to occur.

BGCHI study site was a defined administrative area (F/South Ward of the Municipality of Greater Mumbai) covering an area of 8.8 square kilometres located around the KEM Hospital. The study population consisted of people over 50 years old living in the largest slum and government-built tenement block (*chawl*) settlements within the Ward boundaries. Based on available Municipal data, BGCHI estimated that there were approximately 37,000 people over the age of 50 years living in the Ward, but as much of the area is occupied by industrial mills and factories and large medical and teaching institutions, and because pavement dwellers and smaller slum pockets were not included in the study, BGCHI calculated their target population to be about 3,100 people over 50 years of age. Because of the timing of the nutrition study, we aimed to cover just below half of that number.

Visiting door-to-door, BGCHI social workers conducted a household census of the largest slum and tenement blocks in F/South Ward from which a list of all those over 50 years old was extracted. There may have been some underestimation of the true population of the over 50's as some were missed during the survey and there may also have been some falsification due to hostility or fear. However, we believe that the subjects seen in this study are generally representative of low-income elderly people living in the large slums and government-built tenement blocks in F/South Ward of Greater Mumbai.

Our socio-economic survey revealed that well over half (58%) of elderly people in the study area had no education at all, the rest having only basic schooling and low levels of literacy, especially amongst women. Only a third of the subjects were self-supporting, the rest being dependent on others. The overwhelming majority (98%) lived with other family members or friends, with only 2% living alone. Most elderly people (95%) lived in a single room, with five other people on average. Hinduism was the dominant religion (90%). Nearly three quarters of subjects had lived in Mumbai for more than 20 years.

Both slum and tenement blocks areas are overcrowded, and suffer from poor environmental and sanitation conditions, irregular water and electricity, and inadequate access to health care and social services. Preliminary analysis of the prevalence of health problems in the sample revealed the following : bilateral cataracts (54%), musculo-skeletal problems (40%), low haemoglobin (39%), hypertension (17%), skin infections (11%), chronic obstructive pulmonary disease and gastro-intestinal problems (each 6%), cardiovascular problems (5%), tuberculosis (4%), diabetes, neurological and upper respiratory tract infections (each 3%), and urogenitary problems (1%).

Methodology

Study implementation

Fieldwork was coordinated by one of the authors (MM) who recruited and trained a local team (doctor, social scientist supervisor, six field workers, two social workers) most of whom had previous experience of social work or primary health care in slums. The field team set up a temporary clinic in each community by turn in F/South Ward. About 30 elderly people were contacted daily from the census list and invited to the community clinic. Arrangements were made for home visits to elderly people who were too sick or frail to attend the clinic. Each subject signed (or made a thumb impression) an informed consent form after both social workers and medical officers in the field had fully explained the BGCHI objectives, facilities, examinations and confidentiality on previous occasions in home visits. An awareness programme using local organisations and word of mouth was used to publicise the clinics.

Anthropometric data collection

A range of 11 anthropometric measurements (weight, standing height, mid-upper arm and maximal calf circumferences, biceps, triceps, subscapular and suprailiac skinfolds, and armspan, demispan and knee height as approximates of stature) were conducted according to standard methodologies. Only weight, circumferences and skinfolds will be covered in this paper. Arm skinfolds were taken in triplicate but all other measurements were repeated twice only. Subjects moved between replicate measurements.

Weight was measured on digital weighing scales (Soehnle model S Sport no. 770102), calibrated in 100g units and recorded to the nearest 0.1kg. The scales were placed on level ground adjacent to a wall and footprints drawn on the standing platform to indicate the correct standing position. Subjects removed any heavy items in their pockets or sari waist pouches such as keys and coins. No correction was made for voiding prior to the measurement or the weight of clothing (very light cotton, weighing less than 0.5kg).

Mid-upper arm, and maximal calf circumferences were measured on the left side of the body whenever possible using a flexible steel tape (3 m Stanley tape model 32-031). The arm midpoint was first marked using the distance between the tip of the shoulder (acromial process) and the tip of the elbow (olecranon process), and the mid-arm circumference was then measured with the arm hanging loosely at the side of the body. Calf circumference was measured in the recumbent position with the maximal point determined visually. Both circumference measurements were taken to the nearest 0.1 cm. Care was taken to ensure that the tape fitted snugly around the skin but not so tight that it compressed the tissue.

Triceps, biceps, subscapular and suprailiac skinfold measurements were taken in rapid succession using Holtain Tanner/ Whitehouse calipers. The skinfold was released between each replicate measurement and fingers remained holding the skinfold whilst the calipers were applied. Measurements were recorded to the nearest 0.2mm after at least 3 seconds to allow for the increased compressibility of skin in older subjects[7].

As fluid retention and oedema are known to affect the accurate measurement of weight, circumferences and skin-

fold measurements, depending on the severity and location in the body, any visible oedema (on feet, ankles, legs, arms or face) was noted by the medical officer and field observer.

Quality control and reliability

Each weighing scale was calibrated regularly against local cast-iron weights (total 40kg), and skinfold calipers were checked against wood of known and constant thickness. Recording error was minimised by daily checking of recording forms for obvious mistakes, with any suspect measurement repeated later. As a safeguard against imprecision, we used pre-set limits for repeated measurements[4,7]. These were 0.2kg for weight; 0.5cm for arm and calf circumferences; 1mm for arm skinfolds; and 4mm for trunk skinfolds. If a repeat set of measurements did not fall within its specified pre-set limit the measurement set was repeated.

Intra- and inter- observer errors were calculated for all measurements at the end of the initial training period and mid-way through the fieldwork on 20 elderly volunteers from a day-care centre near the study site. Measurement sessions were conducted blind so that no reference could be made to previous results, and anatomical sites were not marked. The two error estimates recommended to determine reliability, the technical error of measurement (*TEM*), and the coefficient of reliability (*R*), were calculated using the equations for more than two observers[8].

Definition of "elderly" and age determination

There is no consistent definition of "elderly". Many international organisations such as the UN refer to the elderly as those over 60 years of age[9,10], often based on the upper quintile of the population. However, the equivalent upper quintile constituting the "elderly" population in some developing country may mean including people as young as 45 or 50[11]. Moreover, given long-term malnutrition, disease exposure, physical work patterns and generally harsh life conditions common in many developing countries, the process of biological ageing occurs earlier and proceeds faster than in developed populations so that an individual may be biologically "old" at a chronological age lower than 60 years[12]. Taking these factors into account, we took the cut-off 50 years to define our "elderly" population.

There are problems in determining age with accuracy amongst elderly people with low levels of education[13,14]. Some older people, particularly women, are unused to, or suspicious of, completing forms or answering questions about their lives, and many do not have any formal registration of birth. Assuming that self-reported age alone would be inaccurate, we asked a series of questions related to well-known historical events (e.g. the "Quit India" movement, dock explosion in 1944, religious riots) and a secondary series about age at birth of first surviving child, and that child's age. A "best guesstimate" was the mean of all the responses. Out of 1,398 subjects measured, 63 cases were judged to be below 50 years old and have been excluded from the analysis.

Data analysis

All statistical analyses were performed with the Statistical Package for Social Sciences, SPSS/PC version 4.0[15]. Histograms and box plot procedures were used to determine whether or not variables were approximately normally distributed. Pearson's Chi Squared (χ^2) was used to determine whether the prevalence of oedema was related to sex and age, and Yates corrected χ^2 to explore demographic differences. T-tests were used to determine whether sex and community type differences in measurements were significant. The relationships between anthropometric variables and age were first explored using linear regression and plotting residuals, and subsequently in the case of non-linear relationships with t-tests. Pearson product moment correlation coefficients (*r*) were obtained for the examination of the relationships between independent anthropometric variables by gender.

Results

Coverage

Table 1 shows the demographic characteristics of the elderly subjects covered by age group, sex and by type of settlement, presented in five year age groupings. Out of the total study sample of 1,335, the overall sex ratio was 41:59 in favour of females (545 males; 790 females). More than half (53%, n=719) are under 60 years old and 47% (n=616) over 60. Only 158 (12%) are over 70 years old. Males in the whole sample are significantly older than women (χ^2=31.8, df=4, p<.0001). Out of the total sample, 58% (n=777) were from the slums and 42% (n=558) from the tenement blocks. The male : female ratios for slum and tenement block dwellers were not significantly different from the sex ratio for the entire sample. However, slum dwellers were significantly younger than the tenement block dwellers (χ^2=17.1, df=5, p<.001), with 35% of the entire sample made up of slum dwellers under 60 years. The over 60 year-olds accounted for the same proportion in both types of communities (23%). The smallest group was tenement block dwellers under 60 years old (19% of the total sample). The number of housebound elderly subjects seen was 32 (2.4%). There was no association with sex but, as expected, housebound subjects were significantly older than non-housebound subjects, (χ^2=73.4, df=5, p<.0001) with more than half (56%) over 70 years old.

Table 1. Demographic characteristics.

		Totals		M	F	M : F
		n	%	n	N	ratio
Totals	**All**	1335	100	545	790	41 : 59
	Slum	777	58	307	470	40 : 60
	Chawl	558	42	238	320	43 : 57
Age						
50 - 54	**All**	390	29	121	269	31 : 69
	Slum	254	19	72	182	28 : 72
	Chawl	136	10	49	87	36 : 64
55 - 59	**All**	329	25	125	204	38 : 62
	Slum	211	16	83	128	39 : 61
	Chawl	118	9	42	76	36 : 64
60 - 64	**All**	298	22	142	156	48 : 52
	Slum	165	12	78	87	47 : 53
	Chawl	133	10	64	69	48 : 52
65 - 69	**All**	160	12	85	75	53 : 47
	Slum	84	6	47	37	56 : 44
	Chawl	76	6	38	38	50 : 50
> 70	**All**	158	12	72	86	45 : 55
	Slum	63	5	27	36	43 : 57
	Chawl	95	7	45	50	47 : 53

Table 2. Descriptive statistics of anthropometric variables by age group and sex.

		Age group in years									
		50 - 54		55 - 59		60 - 64		65 - 69		> 70	
		M	F	M	F	M	F	M	F	M	F
Weight (kg)	**n**	119	262	121	194	137	149	83	72	68	85
	mean	53.6	46.5	52.8	46.1	53.8	45.3	53.0	45.6	49.7	39.4
	SD	13.2	10.1	11.6	9.9	10.5	11.7	10.8	9.7	9.5	9.9
	minimum	26.8	28.5	34.8	25.4	30.2	23.9	30.5	26.3	29.9	23.4
	maximum	117.9	73.2	101.8	75.8	86.5	93.0	85.4	70.3	71.0	77.3
MUAC (cm)	**n**	120	262	121	195	138	151	83	72	69	86
	mean	24.3	23.8	24.3	23.2	24.3	22.8	23.8	22.6	22.6	20.6
	SD	4.0	3.6	3.3	3.7	3.2	4.2	3.3	3.4	2.7	3.8
	minimum	15.1	15.5	16.0	15.3	18.0	13.5	16.5	15.8	16.0	14.8
	maximum	37.4	34.3	34.5	34.0	31.3	34.0	31.5	31.3	27.5	30.3
Calf circum (cm)	**n**	120	262	121	194	138	151	83	72	69	84
	mean	29.6	27.7	29.4	27.3	29.3	26.8	29.1	26.8	28.0	24.5
	SD	3.7	3.4	3.4	3.3	3.4	3.8	3.3	3.3	3.0	3.1
	minimum	20.0	21.3	23.0	20.3	21.0	17.8	21.3	20.3	21.0	17.8
	maximum	39.4	37.3	38.4	36.8	38.0	37.3	36.5	36.3	36.0	31.8
Triceps (mm)	**n**	120	262	121	195	138	151	83	72	69	86
	mean	10.0	15.3	9.7	14.5	10.2	14.1	10.8	13.3	9.6	10.8
	SD	5.2	6.6	4.3	6.5	4.1	6.5	5.0	5.3	4.2	5.7
	minimum	3.0	3.9	3.0	2.0	3.1	2.0	2.9	4.3	3.0	2.5
	maximum	37.4	38.7	27.9	33.5	23.4	35.9	26.2	30.0	21.0	27.5
Biceps (mm)	**n**	120	262	121	195	138	151	83	72	69	86
	mean	4.6	5.8	4.4	5.8	4.6	5.6	4.7	5.3	4.3	4.5
	SD	2.6	3.1	2.0	3.1	2.1	3.0	2.1	2.3	1.8	2.4
	minimum	1.9	2.0	1.9	1.5	1.7	1.7	2.1	2.1	2.1	1.8
	maximum	20.1	23.7	11.9	22.2	13.2	19.1	13.9	14.0	10.9	14.5
Subscap (mm)	**n**	120	262	121	195	138	151	83	72	69	86
	mean	17.3	23.5	16.0	21.7	16.0	20.9	16.0	21.0	13.9	15.5
	SD	8.6	9.8	8.1	10.7	7.5	10.6	7.3	9.9	6.3	9.6
	minimum	4.5	3.9	5.1	3.2	4.8	2.8	5.3	5.7	4.9	4.0
	maximum	40.0	40.0	39.4	40.0	38.6	40.0	25.1	39.6	36.3	40.0
Suprailiac (mm)	**n**	120	261	121	193	138	151	83	72	69	83
	mean	15.1	21.3	14.4	20.8	14.3	19.4	13.6	19.9	12.3	15.3
	SD	8.0	9.4	7.4	9.7	6.6	9.9	5.8	8.4	5.9	8.7
	minimum	3.0	4.5	3.2	5.0	2.3	3.5	3.1	6.8	3.6	3.9
	maximum	39.0	40.0	38.8	39.6	33.1	39.4	28.1	38.4	30.7	40.0

All cases with oedema are excluded

Table 3. Percentiles for anthropometric variables by sex.

	Weight (kg)		Muac (cm)		Calfcir (cm)		Triceps (mm)		Biceps (mm)		Subscap (mm)		Suprail (mm)	
%ile	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
5	36.7	30.0	18.2	16.9	23.8	21.8	4.1	5.2	2.1	2.4	6.1	6.2	5.0	6.5
10	39.6	32.7	19.5	18.2	25.0	22.8	4.9	6.2	2.4	2.7	7.5	8.0	5.9	7.8
20	42.6	35.9	20.9	19.5	26.2	24.0	6.0	8.0	2.9	3.3	8.9	10.5	7.7	10.6
30	46.0	38.8	22.0	20.8	27.2	25.0	7.2	10.0	3.2	3.7	10.9	13.6	9.4	13.5
40	49.0	41.4	23.1	21.8	28.1	25.8	8.3	11.7	3.6	4.3	12.4	17.7	11.2	16.4
50	51.9	44.3	24.0	22.8	29.0	26.8	9.5	13.1	4.1	4.9	14.1	21.1	13.2	19.5
60	55.4	47.2	25.0	24.3	30.0	27.8	10.6	15.6	4.4	5.6	16.9	24.4	15.3	21.7
70	58.5	50.2	26.0	25.0	31.0	28.8	11.6	17.5	5.1	6.3	19.2	28.4	17.3	24.8
80	61.5	53.7	27.0	26.3	32.1	29.8	13.0	19.6	6.0	7.4	23.0	31.5	19.9	28.8
90	67.6	59.8	28.2	28.0	33.5	31.8	16.2	23.5	7.2	9.1	27.1	36.5	24.0	34.0
95	70.8	64.6	29.5	29.8	35.0	33.3	18.3	25.9	8.7	11.3	31.0	40.0	27.1	38.0

A total of 297 eligible subjects did not participate, giving a participation success rate of 78%. We found a significant sex difference with women more likely to be participants than men (χ^2=22.8, df=2, p<.0001), and the overall male : female ratio amongst the non-participants was 56:44, a reversal of that in the participant sample. For both sexes, non-participation was significantly higher in the younger old (below 60 years) than in the older old (over 60 years) (χ^2=8.1, df=2, p<.001 in males: χ^2=21.5, df=2, p<.0001 in females). From socio-economic information recorded in the initial survey, we determined that approximately 40% of all 297 non-participants were working, of which 82% were men. Non-participant subjects of both sexes under 60 years were far more likely to be working than those over 60 years (χ^2=27.1, df=2, p<.0001

for men; χ^2=7.1, df=2, p <.001 for women). We followed up 101 non-participants over 60 years of age (34% of all non-participants) and found that indeed work, or the search for work, were the main reasons given for non-participation in the study.

Anthropometric descriptives

There was noticeable oedema in 38 subjects (2.8%) which was more common in the feet and ankles (74%) than in the upper body (26%). No associations were found between the presence of oedema and age or sex. Oedematous subjects were significantly heavier than non-oedematous subjects (t=-4.9, df=1326, p<.0001), and had significantly greater skinfolds and circumference (p<0.0001). Thus we excluded cases with oedema from the analysis, leaving a total sample size of 1,297 (531 males and 766 females). Excluding the cases with oedema eliminated much of the skew and kurtosis in the distributions of most variables, which then approximated normality. However, some degree of positive skew still persisted in the distributions of trunk skinfolds in women.

Descriptive statistics (mean, standard deviation, and range) for all variables by age group and gender are presented in Table 2. Overall percentiles are presented by gender in Table 3.

Relationships with dependent and independent variables

Using t-tests, the effects of sex were significantly present for all variables at the p<.0001 level. Males were significantly heavier than females with thicker arm and calf circumferences, whereas females had significantly fatter skinfold thicknesses at all four sites.

There were also differences in some anthropometric measurements by type of community in men, but not in women. Slum-dwelling men (mean weight 52.6kg) were significantly lighter (p<.01) than men living in tenement blocks (mean weight 56kg). Mean triceps, biceps and subscapular skinfolds and both circumferences were also lower in male slum dwellers but not significantly so. The differences were within the pre-set limits for each measurement.

In this cross-sectional sample, all anthropometric variables showed a downward but non-linear trend with increasing age. There is a marked step effect in all variables at the age cut-off 70 years in both sexes, but it is particularly strong in women. In contrast, we found that, in men, only MUAC (t=3.7, df=529, p<.0001), and calf circumference (t=3.2, df=529, p<.001) are significantly associated with the age cut-off 70 years. In women, all variables are significantly associated (p<.0001) with the age cut-off 70 years.

Correlation coefficients (*r*) between independent anthropometric variables were examined. The results are presented as a correlation matrix in Table 4. The strongest relationships were between weight and the circumferences in both sexes, and between MUAC and triceps, and MUAC and calf circumference in women.

Missing values

Anthropometric measurements that could not be taken in the standard way due to deformity, amputation, physical pain or any other reason were recorded as missing values. The missing values (n=6, women only) for the suprailiac skinfold relate to difficulties picking up the skinfold correctly. A small number of calf circumference values (n=3, women only) were missing due to difficulties transferring to the floor. There were no missing values for any other variable in either sex.

Table 4. Correlation matrix (no oedema cases).

	Males					
	Wt	**Muac**	**Calfc**	**Tric**	**Bic**	**Subs**
Muac	.88					
Calfc	.84	.83				
Tricep	.77	.76	.68			
Bicep	.72	.69	.65	.84		
Subscap	.79	.77	.69	.78	.74	
Suprail	.77	.75	.68	.78	.68	.79
	Females					
	Wt	Muac	Calfc	Tric	Bic	Subs
Muac	.90					
Calfc	.90	.88				
Tricep	.80	.90	.80			
Bicep	.70	.77	.67	.82		
Subscap	.82	.86	.76	.83	.69	
Suprail	.79	.80	.72	.79	.68	.86

All are significant at the p<0.0001 level

Reliability

As the results of error calculations for the initial post-training and mid-point periods were almost identical, only the latter results are presented in Table 5. All intra- and inter-observer TEM's for weight, arm circumference, triceps and subscapular skinfolds were within the acceptable limits[16]. As expected, TEM's for skinfolds were frequently higher than all other measurements, particularly for the suprailiac. All results for TEM were comfortably within recommended upper limits for TEM at the 0.95 level, and TEM's for triceps and subscapular skinfolds were within the upper limits at 0.99 level of reliability for subjects 18-65 years old[8]. All reliability coefficients (*R*) for both intra- and inter- observer errors were above 0.95 and most were 0.99.

Discussion

This section focuses on the comparison of Mumbai results with other published studies on elderly people, and discusses issues of potential biases in participation, and practical aspects of taking anthropometric measurements in elderly people.

Comparisons with other studies

A summary comparison of anthropometric values (based on means and percentiles) with US and Indian reference data, and other studies of elderly people, is given in Table 6. The weights of both males and females in Mumbai slums are considerably lower than NHANES I and II reference data from the USA[16], with differences in mean weight by age group approximately 20-25 kg in both sexes, and the 50th centile for weight falling above the 95th centile for Mumbai. Mumbai weights are similar to nationally representative Indian slum data[17,18] as well as to other low income groups of older adults in India[19]. However, the weights of our urban sample, although low, are still higher than those of the elderly poor in rural Rajasthan[20] and Andhra Pradesh[21]. Similar patterns emerge for comparisons of triceps skinfold

and MUAC data, as shown in Table 6. Comparable reference data and results from similar studies on other skinfolds are limited. In a European study of elderly people, mean biceps skinfolds, especially for women, are very much higher than those found in Mumbai[22]. There is very little comparative data on calf circumference from Asian populations, although mean calf circumferences for elderly people in the USA are 5-7cm greater than those in Mumbai[31].

Table 5. Technical errors of measurement (TEM) and coefficients of reliability (R).

	TEM		R	
	M	F	M	F
Intra-observer				
Weight (kg)	0.1	0.1	0.99	0.99
Muac (cm)	0.3	0.1	0.99	0.99
Calfcircumf (cm)	0.2	0.2	0.99	0.99
Triceps (mm)	0.3	0.4	0.99	0.99
Biceps (mm)	0.2	0.3	0.98	0.99
Subscap (mm)	0.4	0.5	0.99	0.99
Suprailiac (mm)	0.9	0.7	0.98	0.97
Inter-observer				
Weight (kg)	0.1	0.0	0.99	1
Muac (cm)	0.2	0.3	0.99	0.98
Calfcircumf (cm)	0.1	0.3	0.99	0.99
Triceps (mm)	0.4	0.4	0.99	0.99
Biceps (mm)	0.2	0.2	0.99	0.99
Subscap (mm)	0.4	0.6	0.99	0.99
Suprailiac (mm)	1.0	1.0	0.98	0.95

Table 6. Summary comparison of anthropometrics in elderly people (ref).

Measure	Lower than Mumbai	Similar to Mumbai	Greater than Mumbai
Weight	Rural Rajhasthan (20) Rural Andra Pradesh (21)	India slum ref data (17,18) Hyderabad poor (19) Rural China	USA ref data (16) Boston (23) Holland (22) UK (24) Madras (25) Urban China (26) Rural Malaysia (27) US Asians (29)
MUAC		India slum ref data (17,18) Hyderabad poor (19)	USA ref data (16) Boston (23) Holland (22) UK (24) Urban China (25) Rural Malaysia (27)
Skinfold (triceps)	India slum ref data (17,18)	Phillipines (28)	USA ref data (16) USA (23, 30) Hyderabad poor (19) Rural Malaysia (27) Urban, rural China (26) US Asians (29)

In general, the anthropometric characteristics of the Mumbai sample suggest a nutritional status that is poorer than that found in developed countries, the more economically developed Asian countries, and amongst Asian communities of higher socio-economic status. Our results are broadly similar to those found amongst other Asian communities of low socio-economic status, although relatively few such studies exist.

Changes in weight and other body compositional variables with old age have been well documented in longitudinal studies and have been attributed to both birth-cohort effect (secular trend) as well as biologically age-related loss[32,33]. However, cross-sectional studies of elderly subjects report varying degrees of relationships between different anthropometric variables and age. For example, Woo *et al*[34] did not observe any age-related decline in any body compositional variables amongst healthy active Hong Kong Chinese elderly but in Malaysia, younger women were significantly heavier with higher prevalence of excess body fat and more body muscle than older women[27]. Our findings of high correlation between weight and circumferences and skinfolds also agree with a number of other studies of elderly people[23,35].

Participation

Our male: female ratio is consistent with various findings that male mortality rates are higher than females mortality rates after middle age[36], and that overall life expectancy in India is higher for elderly females as compared to elderly males[5]. It has been noted for some time that, over the age of 60, women tend to predominate in urban slum areas[37].

High response rates in community-based studies are thought to be more difficult to achieve with elderly people than with other age groups[38]. Our participation rate of 78% compares well with other studies involving elderly people: whilst some have high rates in the 80's and 90's[39,40], others are in the 60's[38,41], or even less[42]. Some studies suggest that non-responders are of poorer health than respondents[40,42,43], that participation is likely to be lower amongst those who are socially isolated, apathetic, depressed or mentally impaired[44], and that men often respond better than women[41]. However, others have concluded that non-response may also be high amongst elderly people in good health, still busy in the community, and who do not see themselves as being part of the "elderly" population[39,45]. Our finding of men participating less than women appears to be the reverse of a study of community-living elderly people in Edinburgh in which a preponderance of women non-respondents was attributed to "elderly women being more fully occupied than elderly men and less willing to spare time for examination"[41]. Despite our attempts to minimise this problem by holding periodic Sunday clinics, our finding probably reflects the marked gender division of work in which women are home-based and can manage time to visit the nearby clinic whereas men leave the community in search of work. Our proportion of older working non-participants corresponds closely to the analysis of the 1981 census results in which 40% of the entire Indian population over 60 years old were found to be working, and of these 83% were men and only 17% women[5]. We might assume that working non-participants were in fairly good health and had high levels of functional ability.

Practical aspects of measurement

Comparative reliability data for anthropometric surveys involving elderly people and elderly patients are limited[46,47]. Moreover basic data to validate the reliability of skinfolds in elderly people are not yet available in sufficient quantity[48,49]. Minimising error in skinfolds is important because of the error that can be introduced into the

prediction of body fat and muscle areas through equations[7]. Skinfold measurements are reported to have greater TEM's than other anthropometric measurements. Large suprailiac skinfolds in particular are known to be difficult to measure[50]. In this study, the habitual wearing of the tight waist cord under the sari often results in a "groove" in the natural suprailiac fatfold, especially in fatter women, so that the skinfold is, in effect, cut in half. Measurement of the biceps skinfold was occasionally difficult in very thin individuals in whom care had to be taken to avoid prominent veins at the measurement site. Locating the correct anatomical site for the skinfold measurement and the degree of caliper pinch can affect the extent of observer error in skinfolds[51]. Compressibility varies according to sex and age[52,53]. Reliability, particularly for arm skinfolds and circumferences, has been found to improve as the amount of subcutaneous tissue decreases. As our elderly subjects tended to be thinner than many of the western populations reported in the literature, it is not surprising that our reliability rates are relatively high, with our TEM's for triceps and subscapular skinfolds lower than those reported for US reference data and other work[48].

We conclude that old age is not necessarily an intrinsic barrier to obtaining consistent and reliable anthropometric measurements. We found the amount of error for which comparable reference data are available was acceptable and within recommendations, which leads us to question the assertion that larger errors of measurement can be expected in studies of elderly persons in poor health and/or with limited mobility[7].

Conclusion

We agree with Solomons and co-authors[14] that field anthropometric surveys are feasible amongst poor community-living elderly people in developing countries despite constraints of lack of space, light, non-specialist staff, and a largely uneducated population. Our own sequence of 11 anthropometric measurements rarely took more than ten minutes. Only minimal portable equipment is required which can be adapted to field conditions. Even in-home assessments of housebound elderly people, which pose particular challenges to quality control and standard methodologies, were successfully accomplished. Key points to emphasise are that staff should be sufficiently trained, patient and sensitive to the particular physical problems affecting older people, that there is adequate privacy, that the research is carried out in the community itself, same-sex observer teams are preferable, and that due attention should be paid to ensuring standard methodology despite the local contexts of clothing and cultural acceptability.

There is a definite need to develop locally appropriate geriatric assessment methodologies and local standards for anthropometric indicators of nutritional status in elderly people[9] and relating these to functional performance[49,54,55]. Developing countries with rapidly ageing and urbanising populations like India must urgently gather their own information on the nutritional health and functional ability of their elderly citizens. The forthcoming papers from this study will generate new data on both the prevalence of malnutrition and impaired function of low-income people aged over 50 years living in an Indian urban environment, as well as on the relationships between anthropometric indices of nutritional status and functional ability.

Acknowledgements. The authors wish to acknowledge the contribution of colleagues at HelpAge International, HelpAge India, and the BGCHI and KEM Hospital in Mumbai. We wish to thank especially Dr. (Mrs) P.M. Pai, Dean of KEM Hospital; Dr. (Mrs) K.C. Gupta, Professor and Head of the Department of Pharmacology; Miss S.M. Pohujani, Mrs K.N. Joshi and Miss V.J.Ashar of the BGCHI; and Major General (Rtd) R.S. Pannu, Director General of HelpAge India for their crucial support. We pay tribute to the late Erica Wheeler for her early initiatives in this research and are grateful to Geraldine McNeill for her comments on a draft of this paper. The research is funded by HelpAge International.

Weight, skinfolds and circumference characteristics of poor elderly people in Mumbai, India

MC Manandhar, PS Anklesaria and SJ Ismail

Asia Pacific Journal of Clinical Nutrition (1997) Volume 6, Number 3: 191-199

印度 Mumbai 貧窮老人的體重，皮褶和體圍特征

摘要

作者選擇了住在 Mumbai 中部（孟買市）教學醫院周圍的貧民區居民1335人（男性 545人，女性 790 人），年齡在50－95歲（平均60歲）爲對象，進行了人體測量，計算并統計了體重，中上臂圍，腓腸肌圍和二頭肌，三頭肌，肩胛骨下和盆骨上皮褶．結果發現，與年齡，性別配對的美國人群比較，測定對象的體重較輕，體圍較小，但與印度貧窮人群和亞洲人群相似．男性的體圍和體重明顯大于女性，而女性的皮褶明顯大于男性．除男性的中上臂圍和腓腸肌圍外，女性的年齡與所有變數没有明顯的綫性關系．所有測量的準確性很高（R>0.95），測量技術誤差最大的是皮褶，特别是盆骨上皮褶．測量對象水腫的發病率爲2.8％．所有對象中男性年齡較女性大，尤其是65歲年齡組．78％對象接受了人體測量，女性多于男性．不參加者幾乎一半與工作有關．本文集中討論了社會中老年人的人體測量及其準確性．

Weight, skinfolds and circumference characteristics of poor elderly people in Mumbai, India

MC Manandhar, PS Anklesaria and SJ Ismail

Asia Pacific Journal of Clinical Nutrition (1997) Volume 6, Number 3: 191-199

भारत में मुंबई के गरीब प्रौढ़ लोगों की वजन, खाल की झुर्रियां तथा परिधिगत विशेषताएं

मानंधर, एम॰ सी॰ अंकलेसरिया, पी॰ एस॰ * एवं इस्माइल, एस॰ जे॰

इस पेपर में मध्य मुंबई (बंबई) में स्थित एक बड़े शिक्षण अस्पताल के आसपास के घरों तथा झुग्गी झोपड़ियों में रहने वाले 50-97 वर्ष की आयु (मध्यम आयु 6 वर्ष) वाले निम्न सामाजिक-आर्थिक वर्ग के 1,335 (पुरुष 545, महिलाएं 790) की मानवमितीय विशेषताओं का वर्णन किया गया है॰ वजन, भुजा के ऊपरी मध्य भाग तथा पिंडुली की परिधि, द्विशिराओं, त्रिशिराओं, सबस्कैपर सुप्रालियक खाल की झुर्रियों के विस्तृत आंकड़े दिये गये हैं॰ उपर्युक्त चीजें उनकी आयु और लिंग के अमेरिकी सहभागियों की अपेक्षा अधिक हल्के, दुबले-पतले तथा कम परिधि के पायी गई किंतु भारतीय झुग्गी झोपड़ी समूहों तथा एशिया के समूहों के राष्ट्रीय प्रतिनिधित्व के समरूप पाई गई॰ महिलाओं की अपेक्षा पुरुष ज्यादा भारी थे तथा बड़ी परिधि वाले थे जबकि महिलाओं की खाल की झुर्रियां अधिक मोटी थी॰ आयु पर्याप्त मात्रा में तथा बिना रेखा के महिलाओं के सभी परिवर्तनों से संबंधित थी किंतु 70 वर्ष तक की आयु वाले पुरुषों में केवल ऊपरी मध्य भुजा तथा पिंडुली की परिधि में परिवर्तन पाया गया॰ सभी मापों की विश्वसनीयता पर्याप्त थी (आर)0.95), किंतु खाल की झुर्रियों विशेषकर सुप्रालियक को मापने में कुछ तकनीकी कमियां रह गयी थी॰ संपूर्णतः ओडेम 2.8 ॰/॰ था॰ संपूर्ण नमूने में महिलाओं की अपेक्षा पुरुष वृद्ध पाये गये शायद इसलिए कि 65 वर्ष से नीचे की आयु में पुरुष, महिलाओं की अपेक्षा अधिक काम करते हैं॰ महिलाओं में पुरुषों की अपेक्षा अच्छी सहभागिता (78 ॰/॰) पायी गयी॰ विशेष रूप से पुरुषों में कार्य से संबंधित गतिविधियों में गैर सहभागिता देखी जा सकती है॰ बहस मुख्यतः समुदाय में रहने वाले प्रौढ़ लोगों में विश्वसनीयता एवं गैर सहभागिता के मानव मितीय मापों से संबंधित व्यावहारिक मुद्दों पर केन्द्रित थी॰

मानव पोषाहार इकाई, सार्वजनिक स्वास्थ्य एवं नीति विभाग लंदन स्कूल ऑफ ट्रापिकल मेडिसिन, 2 टेविस्टन स्ट्रीट, लंदन डब्लूसीआइएच ओबीडी, यू॰ के॰

बायोमेडिकल जेरन्टोलोजी सेन्टर ऑफ हेल्पेज इंडिया, फार्माकोलोजी विभाग, सेठ जी॰ एस॰ मेडिकल कॉलेज एवं किंग एडवर्ड VII मेमोरियल अस्पताल, परेल, मुंबई-400012, भारत॰

References

1. Gopalan C. Nutrition in development transition in South East Asia. New Delhi: World Health Organisation Regional Office for South East Asia, 1992.
2. Friedman PJ, Campbell AJ and Caradoc-Davies TH Prospective trial of a new diagnostic criterion for severe wasting malnutrition in the elderly. Age Ageing 1985; 14: 149-154.
3. Patrick JM, Bassey EJ, Fentem PH 1982 Changes in body fat and muscle in manual workers at and after retirement. Europ J Applied Physiol and Occupational Physiol : 49; 187-196.
4. Chumlea WC, Roche AF and Mukherjee D. Nutritional assessment in the elderly through anthropometry. 2nd ed. Columbus, OH: Ross Laboratories, 1987.
5. Sharma SP, Xenos P. Ageing in India : Demographic background and analysis based on census materials. New Delhi: Office of the Registrar General and Census Commissioner, Ministry of Home Affairs, Occasional Paper 2, 1992.
6. Municipal Corporation of Greater Bombay. 1991 Civic Health Bulletin. Bombay: Information, Education and Communication Cell, Public Health Department, 1991.
7. Chumlea WC, Roche AF, Rogers E. Replicability for anthropometry in the elderly. Human Biology 1984; 56: 329-327.
8. Ulijaszek, S. and Lourie JA. Intra- and inter- observer error in anthropometric measurement. In Anthropometry : the individual and the population. Edited by S.J. Ulijaszek and CGN Mascie-Taylor. Cambridge : University Press. 1994 pp 30-55
9. World Health Organisation. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series 854. Geneva: World Health Organisation, 1995; in press.
10. United Nations. The World Ageing Situation 1991. Vienna, New York: Centre for Social Development and Humanitarian Affairs, 1991.
11. Wahlqvist ML, Lukito W, Hsu-Hage, BH-H. Nutrition and ageing in development. In: Biswas MR, Gabr M, eds. Nutrition in the Nineties: Policy Issues. Delhi: Oxford University Press, 1994: 82-108.

12. Kalache A. Ageing in developing countries. In: Pathy MSJ ed. Principles and Practices of Geriatric Medicine. Chichester UK: John Wiley and Sons Ltd 1991: 1517-1528.
13. Barker JC. Health and functional status of the elderly in a Polynesian population. J Cross Cultural Gerontology 1989; 4: 163-194.
14. Solomons NW, Mazariegos M, Mendoza I. Uses of anthropometry in the elderly in the field setting with notes on screening in developing countries. Asia Pacific J Clin Nutr 1993; 2: 15-23.
15. SPSS Inc. 1987 SPSS Inc., Chicago, USA
16. Frisancho AR. Anthropometric standards for the assessment of growth and nutritional status. The University of Michigan Press, Ann Arbor, USA, 1990.
17. National Nutrition Monitoring Bureau Report on diet and nutritional status of specific groups of urban population (1975-79). National Institute of Nutrition, Hyderabad, 1984.
18. National Nutrition Monitoring Bureau 1988-90 Report of NNMB. National Institute of Nutrition, Hyderabad. Annex II
19. Rao, K.Visweswara, Rau P and Thimmayamma BVS. Nutritional anthropometry of Indian adults. Indian J Nutr Diet 1986; 23 (8): 239-256.
20. Purohit CK and Sharma RAA. A study of nutritional status of persons 60 years and above. Indian J Med Res 1976; 64(2): 202-209.
21. Kullah KM and Ramnath T. Nutritional status of aged in rural areas of Andra Pradesh. Indian J Nutr Diet 1985; 22 (11): 330-336
22. Minten VKAM, Lowik MRH, Deurenberg P, Kok FJ. Inconsistent associations among anthropometric measurements in elderly Dutch men and women. J Am Diet Assoc 1991; 91(11): 1408-1412.
23. Nelson ME and Evans WJ. Macronutrients and anthropometrics. In : Nutrition in the elderly : the Boston Nutritional Status Survey ed Hartz, SC; Russell RM, and Rosenberg IH Smith-Gordon/ Nishimura, London 1992: 55-64.
24. Burr ML, Phillips KM. Anthropometric norms in the elderly. Brit J Nutr; 1984; 51: 165-169.
25. Natarajan VS, Ravindran S, Sivashanmugam,T, Kailash K, Krishnaswamy B, Suresh B and Prabhu P. Assessment of nutrient intake and associated factors in an elderly Indian population. Age Ageing 1993; 22: 103-108.
26. Side X, Mingtang Z, Shuquan M, Zhaomei M, Yinzhi X, Yujun L, Jun W and Kui J. Anthropometric and dietary survey of elderly Chinese. Brit J Nutr 1991; 66: 355-362.
27. Yassin Z and Terry RD. Anthropometric characteristics of rural elderly females in Malaysia. Ecol Food Nutr 1991; 26: 109-117.
28. Garcia PA, Luther T, Serrano FJ, Tan AG Nutrition and health of rural elderly in five selected barangays in the Philippines. Nutr Res: 1982; 2: 545-560.
29. Kim KK, Yu E, Liu WT, Kim J, Kohrs MB. Nutritional status of Chinese, Korean and Japanese American elderly. J Am Diet Assoc 1993; 93: 1416-1422.
30. Falciglia G, O'Connor J, and Gedling E. Upper arm anthropometric norms in elderly white subjects. J Am Diet Assoc 1988; 88: 569-574.
31. Chumlea WC, Roche AF and Mukherjee D. Some anthropometric indices of body composition for elderly adults. J Gerontology 1986; 4: 36-39.
32. Chumlea WC, Garry PJ, Hunt WC and Rhyne RL. Distributions of serial changes in stature and weight in a healthy elderly population. Human Biology 1988; 60 (6): 917-925.
33. Milne JS. Longitudinal studies of body weight and skinfold thickness in older people. J Clin Exper Gerontology 1979; 1(1): 101-122.
34. Woo J, Ho SC, Donnan SPB and Swaminathan R. Nutritional status of healthy, active Chinese elderly. Brit J Nutr 1988; 60: 21-28.
35. Lehmann AB, Bassey EJ, Morgan K and Dallosso HM. Normal values for weight, skeletal size and body mass indices in 890 men and women aged over 65 year. Clin Nutr 1991; 10: 18-22.
36. Murray CJL, Yong G, Qiao X. Adult mortality : levels, patterns and causes. In: Feachem RGA, Kjellstrom T, Murray CJL, Over M, Phillips MA, eds. The Health of adults in the developing world. New York: Oxford University Press for the World Bank, 1992: 23-111.
37. United Nations. The aging in slums and squatter settlements. New York, 1979.
38. Zimmer AW, Calkins E, Hadley E, Ostfield AM, Kaye JM, Kaye D. Conducting clinical research in geriatric populations. Ann Int Med 1985; 103: 276-283.
39. Campbell AJ. Measures to improve the response rate in community based studies of elderly people. J Clin Exper Gerontology 1986; 8: 41-50.
40. Harris T, Woteki C, Briefel RR, Kleinman JC. NHANES III for older persons : nutrition content and methodological considerations. Am J Clin Nutr 1989; 50: 1145-9.
41. Milne JS, Maule MM, Williamson J. Method of sampling in a study of older people with a comparison of respondents and non-respondents. Brit J Prev Soc Med 1971; 25: 37-41.
42. Osler M, Schroll M. Differences between participants and non-participants in a population study on nutrition and health in the elderly. Europ J Clin Nutr 1992; 46: 289-295.
43. Rockwood K, Stolee P, Robertson D, Shillington ER. Response bias in a health status survey of elderly people. Age Ageing 1989; 18: 177-82.
44. Exton-Smith AN. Epidemiological studies in the elderly: methodological considerations. Am J Clin Nutr 1982; 35: 1273-1279.
45. Akthar AJ. Refusal to participate in a survey of the elderly. Geron Clin 1972; 14: 205-211.
46. Mueller WH, Martorell R Reliability and accuracy of measurement. In: Lohman TG, Roche AF, Martorell R. eds. Anthropometric standardization reference manual. Champaign, IL. Human Kinetics Books, 1988.
47. Sullivan DH, Patch GA, Baden AL, Lipschitz DA. An approach to assessing the reliability of anthropometrics in elderly patients. J Am Ger Soc 1989; 37: 607-613.
48. Lohman TG. Skinfolds and body density and their relation to body fatness ; a review. Human Biology 1981; 53(2): 181-225.
49. Durnin JVGA. Anthropometric methods of assessing nutritional status. In: Horowitz A, Macfayden DM, Munro HN, Scrimshaw NS, Steen B, Williams TF, eds. Nutrition in the elderly. New York: Oxford University Press, 1989: 15-32.
50. Frost CS and Corish. Reproducibility of upper-arm anthropometry in subjects of differing body mass. J Human Nutr Diet 1989; 2: 403-406.
51. Chumlea WC, Guo S, Kuczmarski RJ, Johnson CL and Leahy CK. Reliability for anthropometric measurements in the Hispanic Health and Nutrition Examination Survey (HHANES 1982-1984). Am J Clin Nutr 1990; 51: 902S-907S.
52. Brozek J and Kinzey W. Age changes in skinfold compressibility. J Gerontology 1960; 15: 45-51.
53. Himes HJH, Roche AF and Siervogel RM. Compressibility of skinfolds and the measurement of subcutaneous fatness. Am J Clin Nutr 1979; 32: 1734-1740.
54. Kelly PL and Kroemer KHE. Anthropometry of the elderly : status and recommendations. Human Factors 1990; 32: 571-595.
55. Manandhar MC. Functional ability and nutritional status of free-living elderly people. Proc Nutr Soc 1995; 54: 677-691.