



COMPILATION OF ANATOMICAL, PHYSIOLOGICAL AND METABOLIC CHARACTERISTICS FOR A BANGLADESHI MAN

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Abstract

A study has been made to obtain/collect sex specific data on human physical parameters of Bangladeshi population of 9 age groups covering all ages for establishing a Bangladeshi/Asian Reference Man for radiation protection purposes. Eleven physical parameters were considered for measurement, namely height and weight of the total body, sitting height, chest girth, combined height of head and neck, head circumference, head width, neck circumference, length of arm, circumference of arm and length of leg. Significant variation in values of respective parameters was observed in most cases between male and female populations of the same age group. The measured values were compared with those of ICRP Reference Man of caucasian origin. It is observed that the values of physical parameters of Caucasian Reference Man are systematically and probably significantly higher than those of the corresponding Bangladeshi Reference Man. The weights of male and female population of Caucasian Reference Man are approximately 20-30% higher than those of the corresponding Bangladeshi man. Since the organs of the body are roughly proportional to the body weight, the respective masses of the organ would be different by the same ratio factor and could be used for internal dosimetry purposes.

INTRODUCTION

The main objective of the project is to provide data for radiation protection purposes which is relevant to the biokinetics and dosimetric characteristics of the ethnic population in the Asian region. At present, the dose equivalent to different organs, and whole body effective dose equivalent, from both external and internal exposure are estimated on the basis of data for Reference Man of caucasian origin as presented in ICRP Publication 23 [1]. It has since been realized that the ICRP Reference Man data may not necessarily be applicable to the Asian population in general, and the population in Bangladesh, in particular, because of differences in anatomical, metabolic, and physiological parameters, as well as variations in dietary habits, geographical location and other environmental factors. It is, therefore, necessary to obtain relevant local data to establish a logical and realistic Reference Man for the Asian region. It should, however, be noted that these data also differ widely from region to region within Asia.

In order to establish an Asian Reference Man, the International Atomic Energy Agency initiated a Coordinated Research Programme (CRP) in 1988 through the auspices of the Regional Cooperative Agreement (RCA) in Asia and Oceania as part of the RCA program for strengthening of radiation protection infrastructure.

In the earlier stage of the study [2,3], before the commencement of the CRP, the population of Bangladesh had been divided into 7 age groups and an age range of 18-40 years was considered to be a Reference Man. However, in the RCA Meeting [4] held in Mito City, Japan in 1988, it was decided that the human population of different countries of Asia might better be divided into 9 age groups of which the population having the age range of 20-30 years should be considered as a Reference Man, similar to that used by the ICRP [1]. The age

and sex specific data on physical parameters for the population of Bangladesh collected, compiled and analyzed during the period August, 1989 to June, 1990 have been reported accordingly [5].

During the RCA meeting held in Bombay, April, 1991, it was decided that the results of the CRP should be presented in a well defined data format so that the information provided by all participants can be compared. In order to meet this reporting requirement, it was necessary to obtain data at discrete ages of newborn, 1,5,10 and 15 (\pm 6 months), and age ranges from 20-29, 30-39, 40-49 years. But in our earlier study, instead of these discrete age groups, age ranges of 0-1, 2-5, 6-10 and 11-15 years were considered for data collection. So those results could not fulfill the requirement of the CRP report format. During the period March 1993 to August 1993, collection, compilation and analysis of age and sex specific data on physical parameters for the population of Bangladesh have been made using the report format. Sufficient physical parameters and other programme data could not be collected during the whole period of the CRP due to unavoidable circumstances.

Food consumption plays an important role in the physical and physiological characteristics of an individual. The individual's body size and weight, as well as respiratory and metabolic rate are strongly influenced by his food habits. Hence it is necessary to determine the quantitative food intake of the Bangladeshi population. Elemental composition of intake, and their concentration in human tissue is also important to assess the possible uptake and distribution of radionuclides in different body tissues. These intakes are likely to be different from those for Bangladesh and other Asian countries, because of different food habits and geographical locations, ethnic groups with different food habits, different socio-economic and educational status which is a feature of typical developing countries. The daily dietary intake is also likely to be different for different population group living in different locations in the same country.

Under this CRP, covering the period December, 1990 to May, 1993, daily consumption of different Bangladeshi foodstuffs, elemental composition of commonly consumed foodstuffs and consumption of elements of daily dietary intake according to the designed age and sex specific groups are presented.

MATERIALS AND METHODS

For the purpose of our earlier study, covering the period August, 1989 to June, 1990, the population of Bangladesh of both sexes were divided into 9 age groups covering the age ranges 0-1, 2-5, 6-10, 11-15, 16-19, 20-30, 31-40, 41-50 and \geq 51 years. Measurement of 11 different physical parameters have been made for all age groups, as far as possible. The parameters are height, total body weight, sitting height, chest girth, total height of head and neck, head circumference, head width, neck circumference, length of arm, circumference of arm and length of leg. These physical parameters are summarized in Table 1. Results for height, weight, sitting height, chest circumference and head circumference are presented graphically in Fig. 1-5.

In our present study, the population of Bangladesh of both sexes were divided into 8 age groups, covering the discrete ages of newborn, and 1, 5, 10 and 15 (\pm 6 months) years, and age ranges 20-29, 30-39, and 40-49 years. The number of people in each group ranged from 28 to 106 for male and 29 to 123 for females. The measurement of 8 different physical parameters of all age groups have been made. These are height, weight, sitting height, chest circumference, chest width, chest depth, head circumference and neck circumference. The physical parameters are presented in the data report format. The data were collected primarily from the middle class population of urban based socio-economic status, including students from different educational institutions.

TABLE I. AGE AND SEX-SPECIFIC DATA ON THE PHYSICAL PARAMETERS OF THE BANGLADESHI POPULATION

Group Age Range - Years	Sex (No. of Obs.)	Body Height $\pm \sigma$ (cm) [Range]	Body Weight $\pm \sigma$ (kg) [Range]	Sitting Height $\pm \sigma$ (cm) [Range]	Chest Circum. $\pm \sigma$ (cm) [Range]	Height of Head & Neck $\pm \sigma$ (cm) [Range]	Head Circum. $\pm \sigma$ (cm) [Range]
0 - 1	M (60)	62.0 \pm 5.8	6.0 \pm 1.7	N.A.	40.4 \pm 2.5	N.A.	40.2 \pm 3.0
	F (63)	60.0 \pm 4.9	5.3 \pm 1.6	N.A.	38.5 \pm 1.5	N.A.	39.0 \pm 1.6
2 - 5	M (253)	85.4 \pm 8.0 [73 - 96]	10.9 \pm 1.8 [7.9 - 13.2]	50.0 \pm 7.0 [43 - 61]	47.0 \pm 2.0 [43 - 49]	205. \pm 1.0 [19 - 22]	45.9 \pm 1.0 [42 - 47]
	F (238)	82.8 \pm 8.7 [70 - 95]	10.0 \pm 2.0 [7.0 - 12.8]	50. \pm 4.2 [44 - 57]	45.6 \pm 2.2 [42 - 50]	21.0 \pm 1.5 [18 -23]	44.6 \pm 1.1 [43 - 46]
6 - 10	M (260)	124 \pm 8.2 [102 - 135]	22.5 \pm 3.7 [14 - 28]	66.5 \pm 4.3 [57 - 80]	60. \pm 3.4 [51 - 73]	24.4 \pm 1.7 [22 - 30]	51. \pm 1.2 [49 - 53]
	F (216)	115. \pm 7.0 [103 - 130]	19 \pm 3.2 [15 - 27]	64.0 \pm 4.1 [56 - 70]	56.0 \pm 3.0 [57 - 89]	22.6 \pm 1.9 [20 - 28]	50. \pm 1.5 [47 - 52]
11 - 15	M (279)	150.4 \pm 15.2 [127 - 171]	37. \pm 11. [23 - 58]	79.0 \pm 6.0 [70 - 90]	70.3 \pm 9.6 [59 - 84]	27.4 \pm 3.0 [22 - 33]	52.8 \pm 1.6 [49 - 57]
	F (183)	141. \pm 12.6 [124 - 160]	33.0 \pm 9 [20 - 446]	72.8 \pm 7.0 [64 - 75]	71.1 \pm 8.6 [57 - 89]	25.3 \pm 2.0 [22 - 28]	52.3 \pm 1.9 [49 - 53]
16 - 19	M (88)	164. \pm 6.8 [151 - 174]	52. \pm 6.6 [39 - 60]	87. \pm 5. [75 - 96]	80.0 \pm 4.0 [73 - 87]	29.3 \pm 1.0 [28 - 31]	53.7 \pm 2.1 [50 - 58]
	F (109)	150.2 \pm 2.0 [148 - 158]	41.4 \pm 1.7 [39 - 56]	77.5 \pm 2.4 [74 - 82]	81.0 -5.4 [70 - 87]	29.0 \pm 1.7 [27 - 33]	53.4 \pm 1.1 [52 - 55]
20 - 30	M (118)	166. \pm 9.1 [150 - 180]	55.0 \pm 11 [39 - 65]	85.0 \pm 4.5 [75 - 91]	83.2 \pm 6.6 [74 -101]	29.0 \pm 1.6 [27 - 32]	54.7 \pm 1.6 [52 - 57]
	F (63)	153.5 \pm 5.2 [141 - 164]	44.6 \pm 8.0 [30 - 60]	80.5 \pm 2.8 [75 - 88]	85.5 \pm 6.0 [71 - 93]	28.1 - 1.4 [22 - 31]	54.3 \pm 2.1 [52 - 65]
31 - 40	M (62)	166.4 \pm 4.8 [155 - 177]	59.7 \pm 8.5 [43 - 77]	84.3 \pm 4.4 [74 - 90]	89.0 \pm 6.5 [77 - 102]	28.8 \pm 1.8 [26 -36]	54.8 \pm 1.9 [52 - 57]
	F (16)	155.6 \pm 6.6 [142 - 164]	52.2 \pm 10.3 [29 - 66]	79.0 \pm 3.3 [72 - 83]	87.8 \pm 8.8 [66 - 100]	27.3 \pm 1.2 [26 - 30]	54.2 \pm 1.3 [51 - 56]
41 - 50	M (30)	166.5 \pm 1.2 [150 - 170]	57.0 \pm 7.5 [44 - 69]	80 \pm 4.0 [74 - 90]	88.0 \pm 6.5 [75 - 101]	28.0 \pm 1.4 [25 - 30]	54.2 \pm 1.5 [51 - 56]
	F (11)	152.7 \pm 1.6 [143 - 158]	49.6 \pm 8.5 [44 - 64]	74.8 \pm 4.2 [69 - 81]	91.7 \pm 5.0 [86 - 107]	25.7 \pm 2.4 [17 - 30]	53.5 \pm 2.5 [50 - 57]
≥ 51	M (25)	160 \pm 6.0 [150 - 170]	57.0 \pm 7.8 [50 - 70]	77.5 \pm 2.3 [74 - 80]	88.5 \pm 5.0 [83 - 99]	27.2 \pm 1.5 [25 - 29]	54.0 \pm 1.4 [52 - 56]

TABLE I. AGE AND SEX-SPECIFIC DATA ON THE PHYSICAL PARAMETERS OF THE BANGLADESHI POPULATION (CONT.)

Group Age Range - Years	Sex (No. of Obs.)	Head Width $\pm \sigma$ [Range]	Neck Circum. $\pm \sigma$ [Range]	Arm Length $\pm \sigma$ [Range]	Arm Circum. $\pm \sigma$ [Range]	Leg Length $\pm \sigma$ [Range]
0 - 1	M (60)	N.A.	N.A.	N.A.	12.8 \pm 4.2	N.A.
	F (63)	N.A.	N.A.	N.A.	11.8 \pm 1.2	N.A.
2 - 5	M (253)	15.0 \pm 0.4 [14 - 16]	22.8 \pm 1.0 [21 - 24]	20.0 \pm 1.5 [16 - 21]	13.7 \pm 0.5 [13. - 14.3]	49.0 \pm 6.5 [37 - 57]
	F (238)	15.3 \pm 0.8 [14 - 17]	23.0 \pm 1.2 [22 - 25]	20.0 \pm 1.3 [18 - 22]	13.2 \pm 0.6 [12.3 - 13.9]	50.0 \pm 4.5 [46 - 57]
6 - 10	M (260)	16.3 \pm 0.8 [14 - 18]	26.1 \pm 1.4 [24 - 30]	25.2 \pm 1.7 [23 - 30]	17.5 \pm 1.3 [14 - 19]	79.0 \pm 7.0 [59 - 90]
	F (216)	16.0 \pm 0.6 [15 - 17]	25.5 \pm 1.1 [24 - 28]	25.0 \pm 2.9 [22 - 30]	16.0 \pm 1.4 [14 - 19]	68.0 \pm 4.0 [61 - 71]
11 - 15	M (279)	16.8 \pm 0.6 [14 - 18]	28.8 \pm 1.6 [25 - 35]	30.8 \pm 4.3 [26 - 37]	20.2 \pm 2.2 [16 - 25]	93.0 \pm 6.5 [81 - 108]
	F (183)	16.7 \pm 0.7 [15 - 17]	29.0 \pm 2.0 [26 - 31]	31.0 \pm 3.4 [24 - 35]	21.0 \pm 4.6 [16 - 33]	88.2 \pm 5.4 [79 - 96]
16 - 19	M (88)	16.8 \pm 0.8 [15 - 18]	32.3 \pm 2.0 [30 - 37]	33.3 \pm 3.0 [28 - 37]	23.0 \pm 1.6 [21 - 25]	98.0 \pm 3.4 [91 - 102]
	F (109)	16.4 \pm 0.7 [15 - 18]	29.6 \pm 1.8 [27 - 33]	32.0 \pm 2.9 [22 - 39]	22.6 \pm 2.1 [20 - 26]	94.0 \pm 1.6 [92 - 96]
20 - 30	M (118)	17.3 \pm 0.7 [16 - 19]	34.4 \pm 1.6 [30 - 35]	35.6 \pm 2.0 [31 - 39]	26.0 \pm 3.0 [21 - 28]	96.3 \pm 5.0 [92 - 106]
	F (63)	16.2 \pm 1.7 [15 - 18]	30.4 \pm 1.7 [27 - 35]	32.1 \pm 2.0 [28 - 37]	24.1 \pm 2.2 [20 - 29]	96.0 \pm 6.0 [90 - 104]
31 - 40	M (62)	17.3 \pm 0.6 [15 - 19]	33.0 \pm 2.7 [30 - 39]	34.2 \pm 3.1 [31 - 38]	28.8 \pm 2.6 [20 - 30]	97.1 \pm 4.6 [90 - 105]
	F (16)	16.3 \pm 0.8 [15 - 17]	32.3 \pm 2.5 [27 - 36]	33.3 \pm 1.8 [30 - 37]	25.8 \pm 3.5 [20 - 32]	94.4 \pm 4.0 [86 - 102]
41 - 50	M (30)	17.4 \pm 0.8 [16 - 19]	33.0 \pm 2.0 [31 - 37]	35.0 \pm 2.3 [29 - 38]	26.2 \pm 3.6 [22 - 30]	95. \pm 5.3 [80 - 107]
	F (11)	16.7 \pm 1.0 [16 - 18]	33.9 \pm 2.8 [31 - 36]	32.0 \pm 3.5 [28 - 37]	26.7 \pm 3.8 [24 - 31]	94.2 \pm 4.0 [90 - 102]
≥ 51	M (25)	17.4 \pm 0.7 [16 - 18]	34.0 \pm 2.4 [32 - 40]	34.0 \pm 2.7 [28 - 37]	26.0 \pm 2.5 [22 - 30]	95.7 \pm 6.0 [84 - 103]

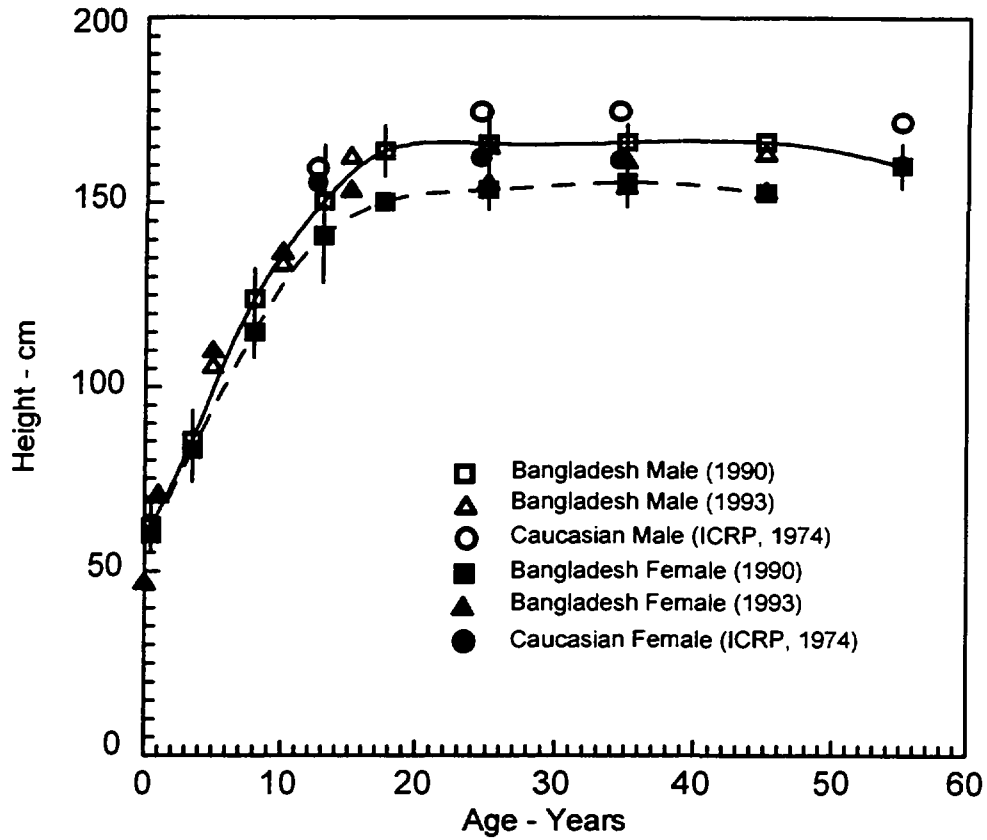


Fig 1 - Body height for Bangladeshi and Caucasian populations

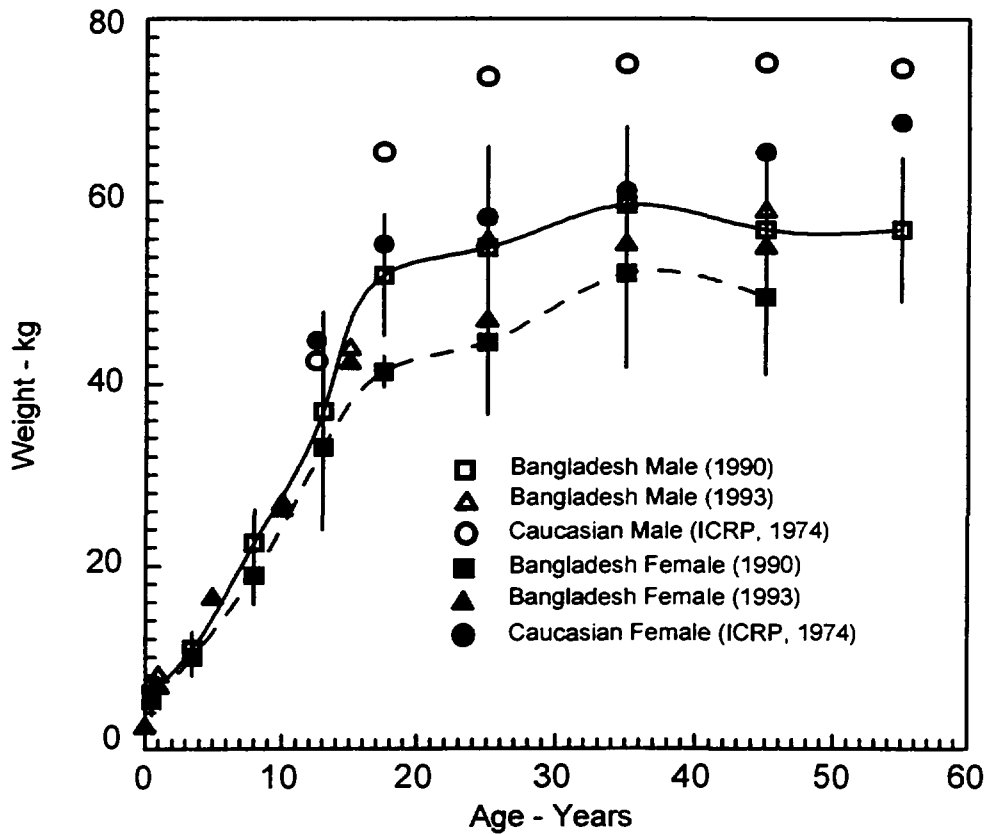


Fig 2 - Body weight for Bangladeshi and Caucasian populations

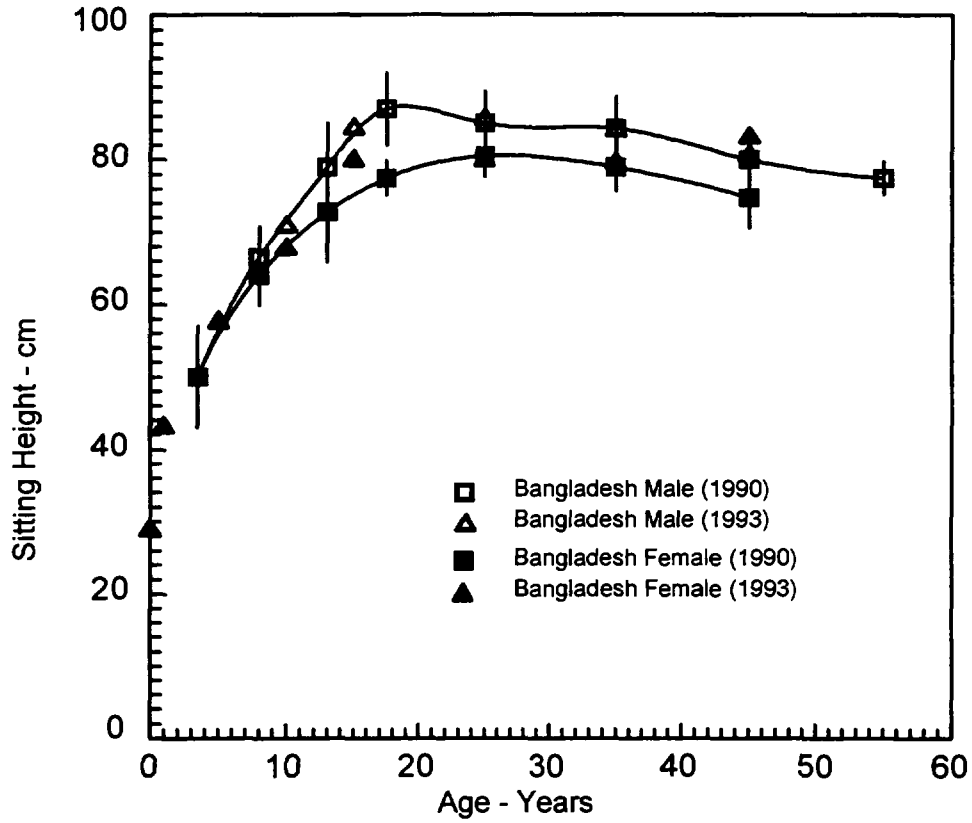


Fig 3 - Sitting height for the Bangladeshi population

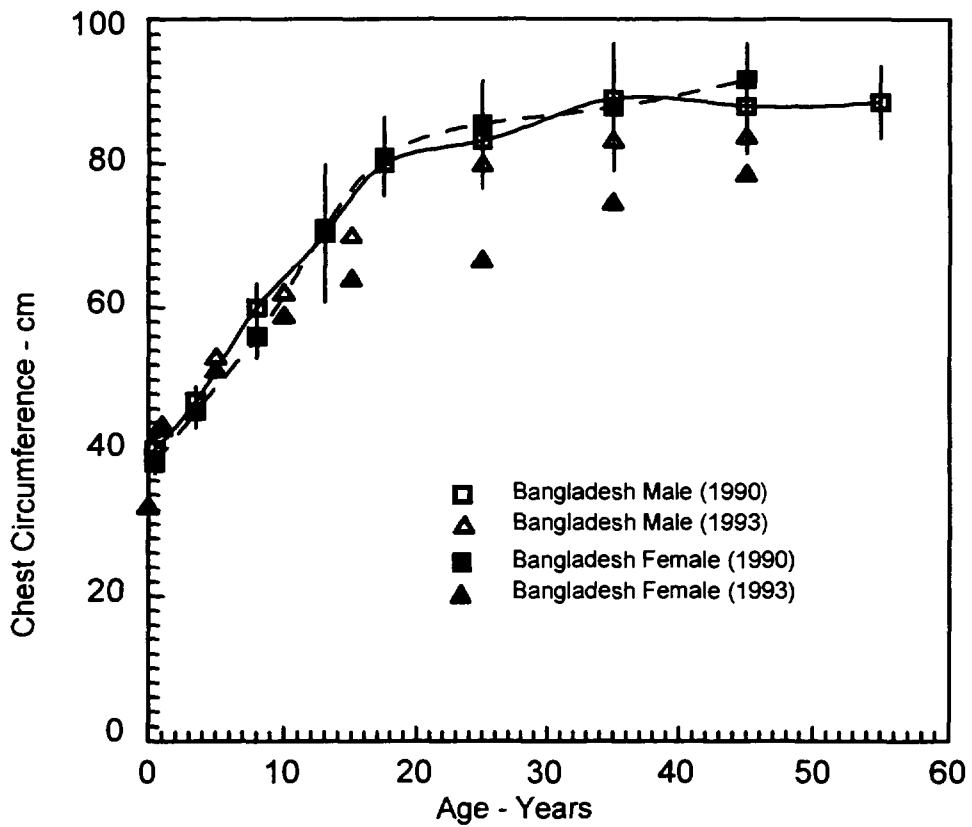


Fig 4 - Chest circumference for the Bangladeshi population

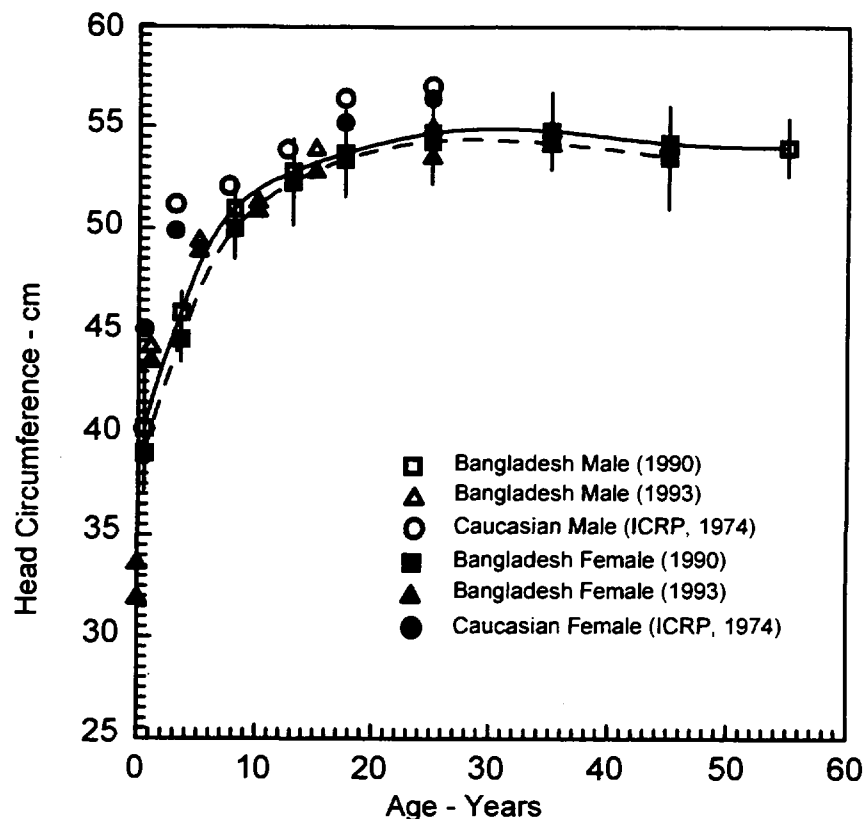


Fig 5 - Head circumference for Bangladeshi and Caucasian populations

For the purposes of daily consumption of different food stuffs and elemental consumption in daily dietary intake, the Bangladeshi population were divided into 7 age groups; newborn, 1, 5, 10, 15 years (± 6 months), and 20-50 and ≥ 50 years. Individuals in the 15, 20-50 and ≥ 50 year age groups have been separated into male and female populations. A nationwide survey of the nutrition of Bangladesh in 1982 was conducted by the Institute of Nutrition and Food Science, Dhaka [6]. A total of 14 locations were chosen in different areas covering the whole of Bangladesh. At least 50 families were sampled for each point. The study was done by interviewing families and obtaining data on the consumption of various foods (weight of raw material, edible part only). In total about 4,315 persons were surveyed. The consumed edible food items were classified into 12 food groups as raw material. The average food intake was determined by twenty four hour food consumption method and expressed in gm/person/day grouping the food as cereals, pulses, potatoes, sugar, fats and oils, fruits, vegetables, fish, meat, eggs, milk, water and beverages. Concentration of different elements in most commonly consumed Bangladeshi foodstuffs were determined by PIXE, XRF and AAS methods [7,8,9,10]. Concentration of 7 elements in 10 food items are presented in Appendix 1. By using these data the quantities of different elements namely K, Ca, Mn, Cu, Zn, Fe and Sr consumed in daily dietary intake by different age groups were determined. These results could not be incorporated in the CRP report format due to the lack of some relevant information required by the format.

RESULTS AND DISCUSSION

Physical Parameters

Sex-specific data in the earlier study on 11 physical parameters collected from 9 age groups of the Bangladeshi population are presented in Table 1 in a summarized form. The

values of five parameters as a function of age for both males and females are shown in Fig. 1 - 5. Detailed discussions of these data have been made in our earlier report [5].

In our present study, 8 different physical parameters for 8 age groups of both sexes of the Bangladeshi population were measured and presented in data format sheets (Table 2). The values of height, weight, sitting height, chest circumference and head circumference obtained in this study as a function of age for both sexes are also shown in Fig. 1-5. The data of the respective parameters obtained from children of both sexes up to the age of about 5 years of Bangladesh and Caucasian populations are almost the same. However, with increasing age there appears to be a significant change in the values of both sexes between the Bangladeshi and Caucasian populations. Our data and interpretation should be used and quoted with caution, since the number of observations used to obtain these data is relatively small.

Figure 1 presents the height as a function of age for both sexes. In the 1993 study, the mean values of heights of all groups in the male population range from 47.3 to 165.4 cm, whereas for females the corresponding values are 47.7 and 155.2 cm. The height of both sexes increases rather rapidly beginning from post-natal stage to an age of 15 years. After that, a small increase in height is observed in males up to 29 years, with no observable change up to 50 years. For females, no significant change occurs in height between 15 years and 50 years.

In Fig. 2, the sex-specific weight data are plotted as a function of age for both male and females in Bangladesh. The 1993 mean values of weight for males have a range from 2.4 to 59.8 kg, whereas for females the range is 2.5 to 55.8 kg. From the post-natal period, the weight of Bangladeshi males and females increases rapidly with age up to 15 years and rather less rapidly between 15-30 years for females. For males, it is same as before. After 30 years there is a slight increase in weight for both male and female, and then there appears a decreasing tendency after 40 years.

Fig. 3 shows the data of sitting height are plotted as a function of age of both males and females. The 1993 mean values for males vary between 29.1 and 86.6 cm and for females 28.3 and 81.3 cm. The data indicate a rapid increase in sitting height with age up to 15 years. For female over 15 years, there is little change. For males, there is a tendency for sitting height decrease after 30 years.

The chest circumference is plotted as a function of age in Fig. 4 as a function of age for both males and females. The chest circumference increases rapidly up to 30 years for males, with a slight further increase up to 50 years. The values for females increase rapidly up to the age of 15 years, but the increase slows up to 30 years. There is then a sharp rise between 30 and 40 years, and continues up to 50 years.

The mean values of chest width as a function of age range between 16.9 and 43.0 cm for males and 15.8 and 41.0 for females (Table 2). the values increase uniformly up to 40 years for males and then remains almost constant up to 50 years. For females, the values increase rapidly up to 10 years, with further slight increase between 10 and 30 years. Then there is an additional rise from 30 to 40 years, with additional slight increase up to 50 years. The mean values of chest depth (Table 2) show a range of 6.1 to 20.8 cm for males and 6.4 to 21.4 for females. The values are observed to increase up to 50 years for females, while for males, there is an increase up to 40 years after which it remains almost constant up to 50 years.

The sex-specific data for head circumference of the head are plotted in Fig. 5 together with the results of the previous study and data for ICRP Reference Man. The ranges of average values lie between 34.2 and 55.0 for males, and 33.7 and 54.2 for females. The value has a rapid increase up to 5 years for both males and females, then increases slowly up to 30 years. After that, there is a slight increase for females and a slight decrease for males. Equivalent data for neck circumference shows an average range from 20.7 to 35.1 for males

TABLE II. AGE AND SEX-SPECIFIC DATA ON CHEST WIDTH, CHEST DEPTH AND NECK CIRCUMFERENCE OF THE BANGLADESHI POPULATION

Age Years	Height cm		Weight kg		Sitting Height cm		Chest Circumference cm		Head Circumference cm		Chest Width cm		Chest Depth cm		Neck Circumference cm	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0	47.4	47.1	2.54	2.66	29.2	28.6	32.4	32.1	34.2	33.7	17.0	15.9	6.1	6.6	20.5	20.0
1	71.3	70.1	8.08	6.96	43.1	43.2	43.9	43.4	44.4	43.8	21.5	20.6	11.3	10.5	21.9	20.9
5	105.9	109.9	16.7	17.0	57.3	57.9	53.4	52.0	49.6	49.0	27.3	28.2	13.4	12.5	24.7	24.3
10	133.9	135.4	27.2	26.7	70.7	67.9	62.3	59.1	51.4	50.9	32.1	32.4	15.7	14.2	27.2	27.2
15	162.8	154.1	43.9	42.5	85.1	80.5	70.5	64.6	54.0	53.0	36.9	33.9	17.8	15.9	31.3	28.9
20-29	165.4	155.2	56.0	47.1	86.6	80.6	80.8	67.6	55.0	53.5	40.5	35.5	19.3	17.0	34.5	30.2
30-39	161.9	154.6	60.7	55.8	84.6	80.2	84.2	75.4	54.9	54.2	42.9	40.0	20.8	19.3	35.6	32.5
40-49	163.9	153.7	59.5	55.4	83.9	81.3	84.9	79.7	54.1	54.1	43.0	41.0	20.6	21.4	35.7	33.0
Total Adult 20-50	163.9	154.9	57.8	49.8	85.7	80.6	82.5	70.8	54.8	53.7	41.9	37.3	20.1	18.1	35.1	31.0

TABLE III. FOOD CONSUMPTION IN GRAMS PER DAY PER PERSON

Foodstuff	Age Group									
	Newborn	(6-18) months	(4.5-5.5) years	(9.5-10.5) years	(14.5-15.5) years		(20 - 50) years		(50 - above) years	
					M	F	M	F	M	F
Cereals	-	50	280	390	470	420	520	490	490	400
Pulses	-	3	10	13	12	9	12	9	10	8
Potatoes	-	5	36	55	60	55	104	70	81	69
Sugar	15	15	18	13	16	10	10	7	13	11
Fats & Oils	-	2	3	3	3	4	6	5	5	5
Fruits	-	5	18	25	28	20	20	18	20	20
Vegetables	-	10	57	100	120	110	150	128	150	120
Fish	-	6	15	18	25	30	40	24	30	20
Meats	-	4	9	9	12	10	14	8	9	4
Eggs	-	10	15	12	8	5	5	4	4	3
Milk	400	125	80	20	10	5	20	10	30	20
Water	100	250	600	1200	1500	1200	1600	1400	1200	1100

M = Male
F = Female

and 20.2 to 33.0 for females (Table 2). There appears to be a systematic increase in neck circumference with age up to 30 years for both males and females. After that the values for males are almost constant up to 50 years. For females, there an increase up to 40 years, remaining almost constant between 40 and 50 years.

Food Consumption

Average food consumption of daily dietary intake per person of 7 age groups of the Bangladeshi population are presented in Table 3. The percentage of each food stuff was calculated on the weight basis of total food consumption, excluding water, for different age groups which are as follows:

- Newborn* - New born babies consume 400 ml milk and 15 gm sugar which may be approximately 95% and 5% respectively of their daily intake.
- 1 Year* - For children in the age range 6 to 18 months, milk and milk products represent 50% of their total diet. In this age group, consumption of cereals is less than other age groups - 20%. All other food items ranged from 0.8 to 6%, of which, consumption of sugar and eggs are a considerable amount.
- 5 Years* - In the age range 4.5 to 5.5 years, consumption of cereals and milk are 51% and 15%, of the total diet, and consumption of vegetables, potatoes, fish, meat, eggs and sugar are 10%, 6%, 2.7%, 1.6%, 2.7% and 3.2% respectively.
- 10 Years* - Persons between 9.5 and 10.5 years consume cereals which contribute of 59% their total diet. In this age group consumption of vegetables and potatoes are considerable amount, 15% and 8% respectively. All other food items range from 1.3% to 3.8%.
- 15 Years* - In Table 3 the individuals in the age range 14.5 - 15.5 years are classified separately by sex groups. Males consume more than females. In this age group cereals are the major portion of the total diet for both sex groups, 62% and 61% for male and female respectively. The next major portion comes from vegetables and potatoes for both sexes. The values range from 8% to 16%. All other food groups range from 0.73% to 3.66%.
- Adult* - The data of Reference Man data is obtained from the age range 20 to 50 years. In this age group, the consumption of total diet is more than other groups. Males consume more than females, of which, cereal is the major portion, 58% for male and 54% for female. The next major portion comes from vegetables, for male 17% and for female 16%, and from potatoes 12% and 9% for male and female respectively. All other food items range from (0.5 - 4)% for male and (0.5 - 3)% for female.
- ≥ 50 Years* - In this age group the overall food consumption is less than the age group of (20 - 50) years. From the table it is observed that the consumption of cereals are more than other food items for both male and female which is 56% and 58% respectively.

TABLE IV. ELEMENTAL COMPOSITION OF NINE COMMONLY CONSUMED FOODSTUFFS PER GRAM OF THE ITEMS

Foodstuffs	Element						
	K (mg)	Ca (mg)	Mn (μ g)	Fe (μ g)	Cu (μ g)	Zn (μ g)	Sr (μ g)
Cereals	1.16	0.12	12.55	15.83	2.55	17.78	-
Pulses	12.55	2.76	19.70	69.60	10.56	66.72	-
Potatoes	3.10	0.28	0.94	2.95	0.93	1.97	-
Vegetables	1.63	0.44	2.36	8.98	0.67	3.38	-
Fish	2.17	4.91	4.23	31.48	5.87	39.60	18.87
Meat	-	0.21	0.48	21.90	1.59	34.61	1.05
Eggs	2.25	0.55	0.26	17.60	0.91	8.83	-
Milk, human	0.85	0.05	0.10	0.51	0.18	0.28	-
Milk, cow	1.95	0.22	-	0.59	0.13	2.92	-
Water	0.001	0.03	0.73	0.119	0.161	0.518	0.341

TABLE V. CONSUMPTION OF ELEMENTS IN DAILY DIETARY INTAKE BY DIFFERENT AGE GROUPS (UNIT IN MG)

Element	Age Group									
	Newborn	(6-18) months	(4.5-5.5) years	(9.5-10.5) years	(14.5-15.5) years		(20 - 50) years		(50 - above) years	
					Male	Female	Male	Female	Male	Female
K	340.	338.	887.	1055.	1171.	1038.	1460.	1195.	1323.	1064.
Ca	23.3	81.	217.	283.	341.	332.	447.	354.	373.	283.
Mn	0.11	0.94	4.39	6.31	7.68	6.77	8.56	7.52	7.78	6.42
Fe	0.22	1.66	6.79	9.29	10.91	9.69	12.49	11.07	11.40	9.08
Cu	0.09	0.28	1.11	1.57	1.88	1.98	2.17	1.86	1.92	1.56
Zn	0.16	1.88	7.44	10.0	11.96	10.5	13.66	12.09	12.26	9.76
Sr	0.03	0.20	0.49	0.76	1.00	0.98	1.32	1.03	0.98	0.76

TABLE VI. ELEMENTAL COMPOSITION OF VARIOUS BANGLADESHI FOODS (MG/G, BASED ON FRESH WEIGHT)

Element	Water			Cow Milk			Human Milk			Meat (beef, chicken and mutton)			Various Fish		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
K	1.30	0.65	3.62	1950.	1600.	2300.	850.	400.	1300.	-	-	-	2170.	1440.	3390.
Ca	33.0	17.6	45.9	223.	129.	317.	50.	40.	60.	208.	21.2	815.	4910.	770.	7540.
Mn	0.73	0.004	0.42	-	-	-	0.10	0.04	0.15	0.48	0.35	0.65	4.24	1.36	7.09
Fe	0.119	0.006	0.20	0.59	0.09	1.1	0.51	0.33	0.70	21.9	9.70	33.0	31.5	16.4	54.0
Cu	0.161	0.004	0.75	0.13	0.10	0.16	0.18	0.12	0.25	1.59	0.53	3.60	5.87	0.50	17.0
Zn	0.518	0.008	2.56	2.92	1.25	4.60	1.04	0.28	1.80	34.6	11.2	53.8	39.6	15.2	62.1
Sr	0.341	0.01	1.06	-	-	-	-	-	-	1.05	0.25	1.60	18.9	6.55	46.3
Element	Eggs			Various Vegetables			Potatoes			Cereals			Pulse		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
K	2250.	1450.	3060.	1630.	430.	2960.	3100.	2080.	4130.	1160.	920.	1450.	12,550.	7020.	16,200.
Ca	550.	400.	700.	440.	140.	2030.	280.	190.	360.	120.	70.	150.	2760	1660.	3740.
Mn	0.259	0.163	0.355	2.36	0.31	8.30	0.94	0.71	1.17	12.6	8.89	18.3	20.	15.4	25.6
Fe	17.6	11.7	23.6	8.98	1.19	34.7	2.95	2.66	3.24	15.8	12.1	25.1	70.	40.4	103.
Cu	0.91	0.41	1.40	0.67	0.09	2.83	0.93	0.73	1.12	2.55	1.93	3.27	10.	3.58	17.4
Zn	8.83	6.70	10.9	3.38	0.11	13.4	1.97	1.70	2.23	17.8	13.4	26.3	70.	54.6	83.5

Elemental Consumption

Elemental composition of 9 commonly consumed foodstuffs per gram of the foods are presented in Table 4. The table shows that per gram of pulse contains the highest amount of potassium, manganese, iron, copper and zinc except calcium. Calcium is highest in per gram of fish. Consumption of 7 elements namely potassium, calcium, manganese, iron, copper, zinc and strontium in the daily dietary intake by different age groups are presented in Table 5. It can be shown from Table 5 that consumption of potassium is highest in each age group. The second highest amount is calcium, then in decreasing order, zinc, iron, manganese and copper and the lowest consumed element is strontium among these seven elements.

As the objective of the programme is to obtain data for the Reference Man (20 -30) years, we have analyzed the data of the elemental consumption of the age group (20 - 50) years, which, as mentioned earlier, falls within the Reference Man. The percent contribution of different food items to daily elemental intake is as follows:

Potassium - The daily average contribution of food items to potassium intake are: cereals, 41.3% for male and 47.6% for female; potatoes, 22% for male and 18% for female; vegetables, 16.6% for male and 17% for female; pulses, 10% for male and 9.4% for female; fish, 6% for male and 5.3% for female and other food items contribute from 0.10% to 2.7% both for male and female.

Calcium - Calcium contribution from total dietary intake is 44% for male and 40% for female from fish; 14% for male and 16% for female from cereals; 14.8% for male and 16% for female from vegetables; 7.4% for male and 7% for female from pulses; 6.5% for male and 5.4% for female from potatoes; 11.8% for male and 13% for female from water, and other foods range from 0.60% to 1.0% both for male and female.

Iron - For iron intake the dietary sources are cereals, 66% for male and 70% for female; vegetables, 11% for male and 10% for female; fish, 10% for male and 8% for female; pulses, 6.7% for male and 5.6% for female and other foods 6.3% both for male and female.

Zinc - The contribution of food to zinc intake is 67.7% for male and 72% for female from cereal; 11.6% for male and 9.5% for female from fish; 5.8% for male and 5% for female from pulses; 6% for both male and female from water and the rest from other foods.

Copper - Contribution of Cu intake from cereals is 61% for male and 64.6% for female and from fish 11% for male and 9% for female. Other foods contribute 28% for male and 26.4% for female.

Manganese - 76% of the dietary contribution of manganese for males comes from cereals, compared with and 81% for female. The rest of the manganese intake comes from other foodstuffs.

Strontium - Strontium is the lowest of the 7 elements studies, detectable only in the food items of fish, meat and water ranging from 18.87 - 0.341 $\mu\text{g}/\text{gram}$ of fresh weight.

It may be noted here from the observed values that the major portion of each elemental intake comes from cereals, except calcium, due to the highest consumption of cereals in our total diet. The contribution to calcium intake is maximum from fish.

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