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Compilation of anatomical, physiological and metabolic characteristics for a Reference Asian Man

Volume 2: Country reports

Results of a co-ordinated research programme 1988–1993

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FOREWORD

The Co-ordinated Research Programme (CRP) on Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man has been conducted as a programme of the IAEA Regional Co-operative Agreement (RCA) for Asia and the Pacific. The CRP was conducted to provide data for radiation protection purposes that is relevant to the biokinetic and dosimetric characteristics of the ethnic populations in the Asian region. The radiological protection decisions that had to be made in the RCA member States following the Chernobyl accident were a significant motivation for establishing the CRP.

Eleven RCA member States participated in the CRP. Research co-ordination meetings (RCMs) for the CRP were held in Mito City, Japan, 17–21 October 1988 and Bhabha Atomic Research Centre, India, 8–12 April 1991. The concluding meeting was held in Tianjin, China, 25–29 October 1993.

Funding for the RCM by the Government of Japan is gratefully acknowledged. The IAEA wishes to thank S. Kobayashi for his efforts in support of the CRP. The IAEA extends its appreciation to the Japanese National Institute of Radiological Sciences for acting as the technical secretariat to co-ordinate the work of data compilation. Specifically, the IAEA acknowledges the contributions of H. Kawamura, G. Tanaka and T. Koyanagi. Appreciation is also extended to the National Institute of Radiological Sciences, Japan, the Bhabha Atomic Research Centre, India, and the Chinese Academy of Medical Sciences for the valuable contribution they made to the CRP as hosts for the RCMs.

The IAEA officers responsible for this publication were A. Moiseev and R.V. Griffith of the Division of Radiation and Waste Safety.

This publication is divided into two volumes: Volume 1 contains a summary of the data and conclusions from the project and Volume 2 the reports from participating countries.

EDITORIAL NOTE

CONTENTS

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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 (± 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 ≥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 (± 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 ± σ (cm) [Range]	Body Weight ± σ (kg) [Range]	Sitting Height ± σ (cm) [Range]	Chest Circum ± σ (cm) [Range]	Height of Head & Neck ± σ (cm) [Range]	Head Circum ± σ (cm) [Range]
0 - 1	M (60)	62 0 ± 5 8	6 0 ± 1 7	N A	40 4 ± 2 5	N A	40 2 ± 3 0
	F (63)	60 0 ± 4 9	5 3 ± 1 6	N A	38 5 ± 1 5	N A	39 0 ± 1 6
2 - 5	M (253)	85 4 ± 8 0 [73 - 96]	10 9 ± 1 8 [7 9 - 13 2]	50 0 ± 7 0 [43 - 61]	47 0 ± 2 0 [43 - 49]	205 ± 1 0 [19 - 22]	45 9 ± 1 0 [42 - 47]
	F (238)	82 8 ± 8 7 [70 - 95]	10 0 ± 2 0 [7 0 - 12 8]	50 ± 4 2 [44 - 57]	45 6 ± 2 2 [42 - 50]	21 0 ± 1 5 [18 -23]	44 6 ± 1 1 [43 - 46]
6 - 10	M (260)	124 ± 8 2 [102 - 135]	22 5 ± 3 7 [14 - 28]	66 5 ± 4 3 [57 - 80]	60 ± 3 4 [51 - 73]	24 4 ± 1 7 [22 - 30]	51 ± 1 2 [49 - 53]
	F (216)	115 ± 7 0 [103 - 130]	19 ± 3 2 [15 - 27]	64 0 ± 4 1 [56 - 70]	56 0 ± 3 0 [57 - 89]	22 6 ± 1 9 [20 - 28]	50 ± 1 5 [47 - 52]
11 - 15	M (279)	150 4 ± 15 2 [127 - 171]	37 ± 11 [23 - 58]	79 0 ± 6 0 [70 - 90]	70 3 ± 9 6 [59 - 84]	27 4 ± 3 0 [22 - 33]	52 8 ± 1 6 [49 - 57]
	F (183)	141 ± 12 6 [124 - 160]	33 0 ± 9 [20 - 446]	72 8 ± 7 0 [64 - 75]	71 1 ± 8 6 [57 - 89]	25 3 ± 2 0 [22 - 28]	52 3 ± 1 9 [49 - 53]
16 - 19	M (88)	164 ± 6 8 [151 - 174]	52 ± 6 6 [39 - 60]	87 ± 5 [75 - 96]	80 0 ± 4 0 [73 - 87]	29 3 ± 1 0 [28 - 31]	53 7 ± 2 1 [50 - 58]
	F (109)	150 2 ± 2 0 [148 - 158]	41 4 ± 1 7 [39 - 56]	77 5 ± 2 4 [74 - 82]	81 0 -5 4 [70 - 87]	29 0 ± 1 7 [27 - 33]	53 4 ± 1 1 [52 - 55]
20 - 30	M (118)	166 ± 9 1 [150 - 180]	55 0 ± 11 [39 - 65]	85 0 ± 4 5 [75 - 91]	83 2 ± 6 6 [74 -101]	29 0 ± 1 6 [27 - 32]	54 7 ± 1 6 [52 - 57]
	F (63)	153 5 ± 5 2 [141 - 164]	44 6 ± 8 0 [30 - 60]	80 5 ± 2 8 [75 - 88]	85 5 ± 6 0 [71 - 93]	28 1 - 1 4 [22 - 31]	54 3 ± 2 1 [52 - 65]
31 - 40	M (62)	166 4 ± 4 8 [155 - 177]	59 7 ± 8 5 [43 - 77]	84 3 ± 4 4 [74 - 90]	89 0 ± 6 5 [77 - 102]	28 8 ± 1 8 [26 -36]	54 8 ± 1 9 [52 - 57]
	F (16)	155 6 ± 6 6 [142 - 164]	52 2 ± 10 3 [29 - 66]	79 0 ± 3 3 [72 - 83]	87 8 ± 8 8 [66 - 100]	27 3 ± 1 2 [26 - 30]	54 2 ± 1 3 [51 - 56]
41 - 50	M (30)	166 5 ± 1 2 [150 - 170]	57 0 ± 7 5 [44 - 69]	80 ± 4 0 [74 - 90]	88 0 ± 6 5 [75 - 101]	28 0 ± 1 4 [25 - 30]	54 2 ± 1 5 [51 - 56]
	F (11)	152 7 ± 1 6 [143 - 158]	49 6 ± 8 5 [44 - 64]	74 8 ± 4 2 [69 - 81]	91 7 ± 5 0 [86 - 107]	25 7 ± 2 4 [17 - 30]	53 5 ± 2 5 [50 - 57]
≥ 51	M (25)	160 ± 6 0 [150 - 170]	57 0 ± 7 8 [50 - 70]	77 5 ± 2 3 [74 - 80]	88 5 ± 5 0 [83 - 99]	27 2 ± 1 5 [25 - 29]	54 0 ± 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 ± σ [Range]	Neck Circum ± σ [Range]	Arm Length ± σ [Range]	Arm Circum ± σ [Range]	Leg Length ± σ [Range]
0 - 1	M (60)	N A	N A	N A	12 8 ± 4 2	N A
	F (63)	N A	N A	N A	11 8 ± 1 2	N A
2 - 5	M (253)	15 0 ± 0 4 [14 - 16]	22 8 ± 1 0 [21 - 24]	20 0 ± 1 5 [16 - 21]	13 7 ± 0 5 [13 - 14 3]	49 0 ± 6 5 [37 - 57]
	F (238)	15 3 ± 0 8 [14 - 17]	23 0 ± 1 2 [22 - 25]	20 0 ± 1 3 [18 - 22]	13 2 ± 0 6 [12 3 - 13 9]	50 0 ± 4 5 [46 - 57]
6 - 10	M (260)	16 3 ± 0 8 [14 - 18]	26 1 ± 1 4 [24 - 30]	25 2 ± 1 7 [23 - 30]	17 5 ± 1 3 [14 - 19]	79 0 ± 7 0 [59 - 90]
	F (216)	16 0 ± 0 6 [15 - 17]	25 5 ± 1 1 [24 - 28]	25 0 ± 2 9 [22 - 30]	16 0 ± 1 4 [14 - 19]	68 0 ± 4 0 [61 - 71]
11 - 15	M (279)	16 8 ± 0 6 [14 - 18]	28 8 ± 1 6 [25 - 35]	30 8 ± 4 3 [26 - 37]	20 2 ± 2 2 [16 - 25]	93 0 ± 6 5 [81 - 108]
	F (183)	16 7 ± 0 7 [15 - 17]	29 0 ± 2 0 [26 - 31]	31 0 ± 3 4 [24 - 35]	21 0 ± 4 6 [16 - 33]	88 2 ± 5 4 [79 - 96]
16 - 19	M (88)	16 8 ± 0 8 [15 - 18]	32 3 ± 2 0 [30 - 37]	33 3 ± 3 0 [28 - 37]	23 0 ± 1 6 [21 - 25]	98 0 ± 3 4 [91 - 102]
	F (109)	16 4 ± 0 7 [15 - 18]	29 6 ± 1 8 [27 - 33]	32 0 2 9 [22 - 39]	22 6 ± 2 1 [20 - 26]	94 0 ± 1 6 [92 - 96]
20 - 30	M (118)	17 3 ± 0 7 [16 - 19]	34 4 ± 1 6 [30 - 35]	35 6 ± 2 0 [31 - 39]	26 0 ± 3 0 [21 - 28]	96 3 ± 5 0 [92 - 106]
	F (63)	16 2 ± 1 7 [15 - 18]	30 4 ± 1 7 [27 - 35]	32 1 ± 2 0 [28 - 37]	24 1 ± 2 2 [20 - 29]	96 0 ± 6 0 [90 - 104]
31 - 40	M (62)	17 3 ± 0 6 [15 - 19]	33 0 ± 2 7 [30 - 39]	34 2 ± 3 1 [31 - 38]	28 8 ± 2 6 [20 - 30]	97 1 ± 4 6 [90 - 105]
	F (16)	16 3 ± 0 8 [15 - 17]	32 3 ± 2 5 [27 - 36]	33 3 ± 1 8 [30 - 37]	25 8 ± 3 5 [20 - 32]	94 4 ± 4 0 [86 - 102]
41 - 50	M (30)	17 4 ± 0 8 [16 - 19]	33 0 ± 2 0 [31 - 37]	35 0 ± 2 3 [29 - 38]	26 2 ± 3 6 [22 - 30]	95 ± 5 3 [80 - 107]
	F (11)	16 7 ± 1 0 [16 - 18]	33 9 ± 2 8 [31 - 36]	32 0 ± 3 5 [28 - 37]	26 7 ± 3 8 [24 - 31]	94 2 ± 4 0 [90 - 102]
≥ 51	M (25)	17 4 ± 0 7 [16 - 18]	34 0 ± 2 4 [32 - 40]	34 0 ± 2 7 [28 - 37]	26 0 ± 2 5 [22 - 30]	95 7 ± 6 0 [84 - 103]

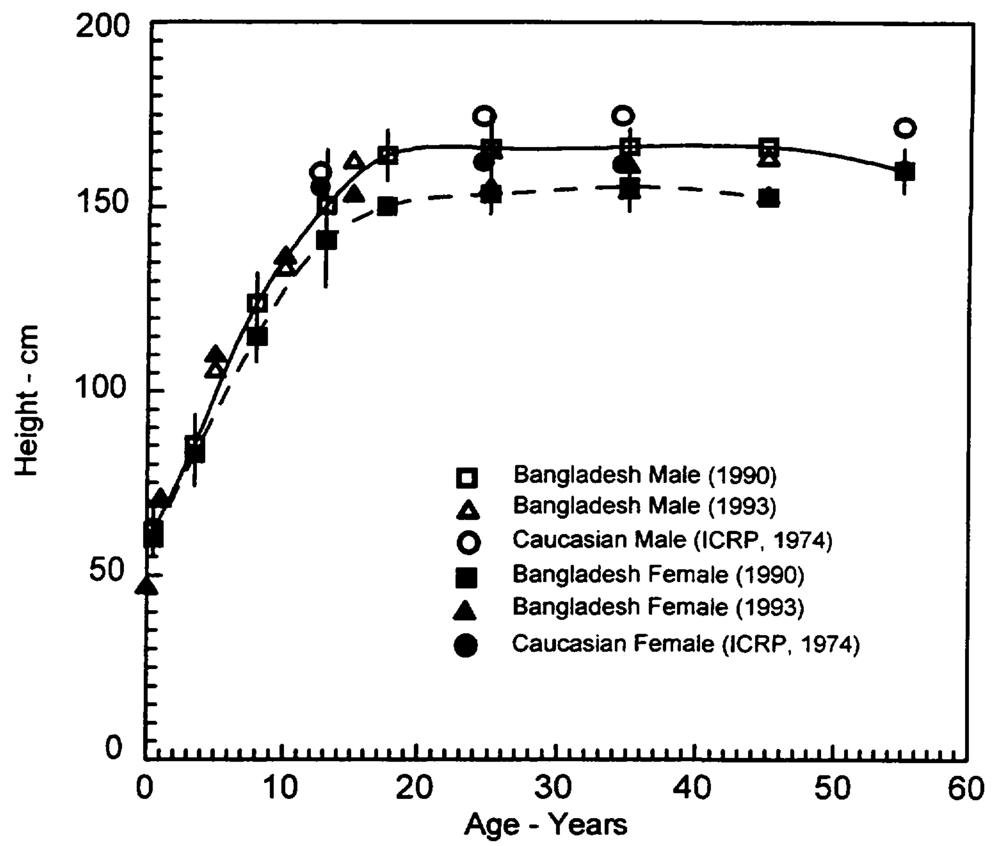

Fig 1 - Body height for Bangladeshi and Caucasian populations

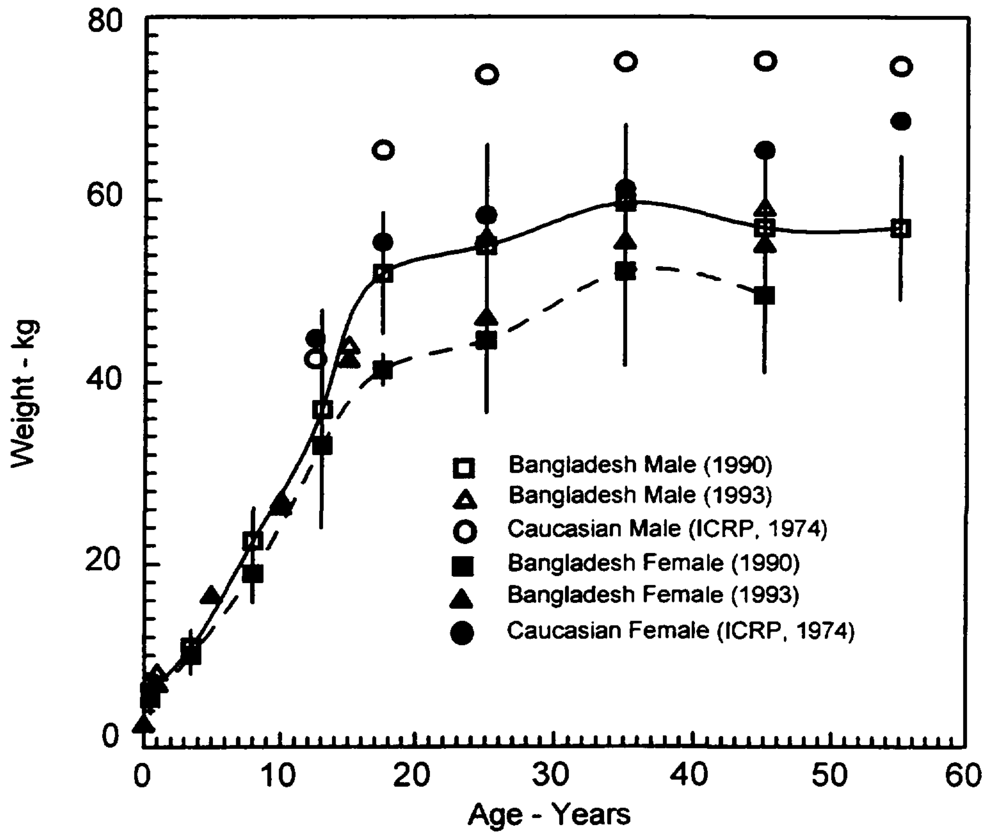

Fig 2 - Body weight for Bangladeshi and Caucasian populations

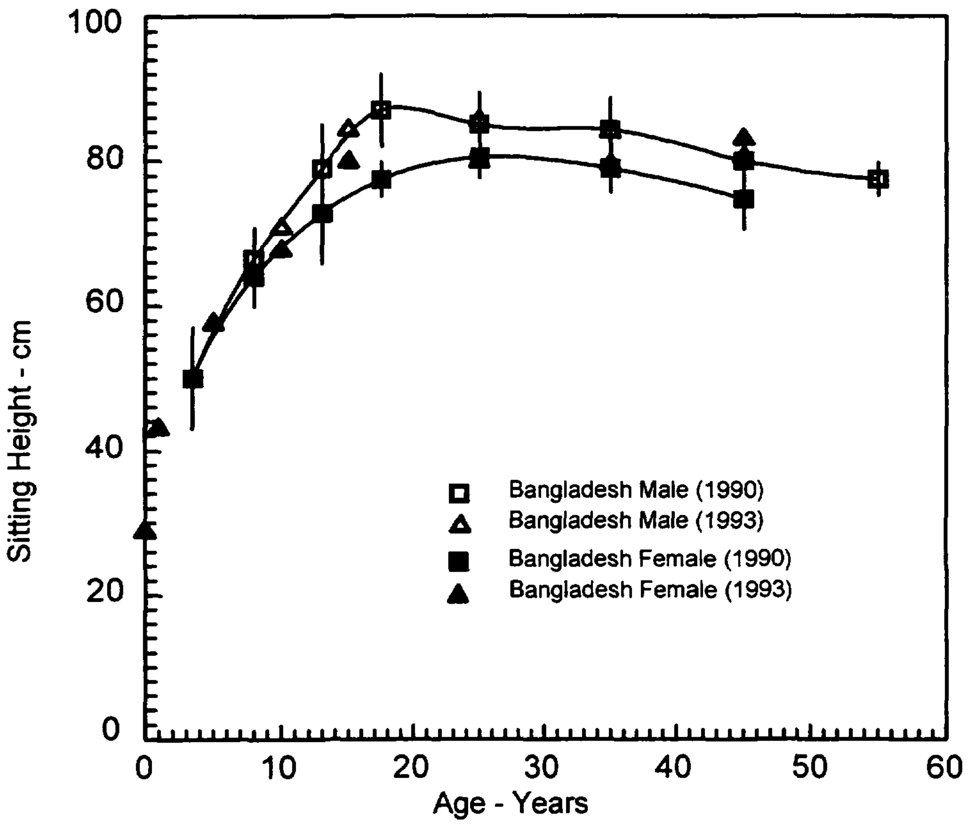

Fig 3 - Sitting height for the Bangladeshi population

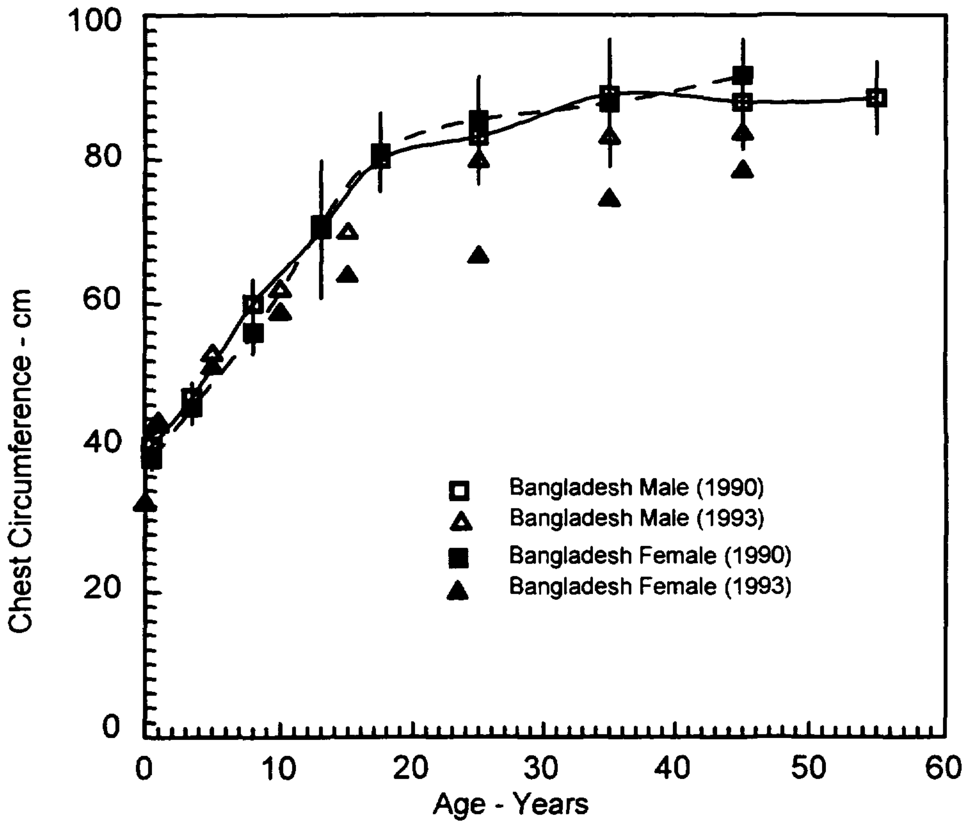

Fig 4 - Chest circumference for the Bangladeshi population

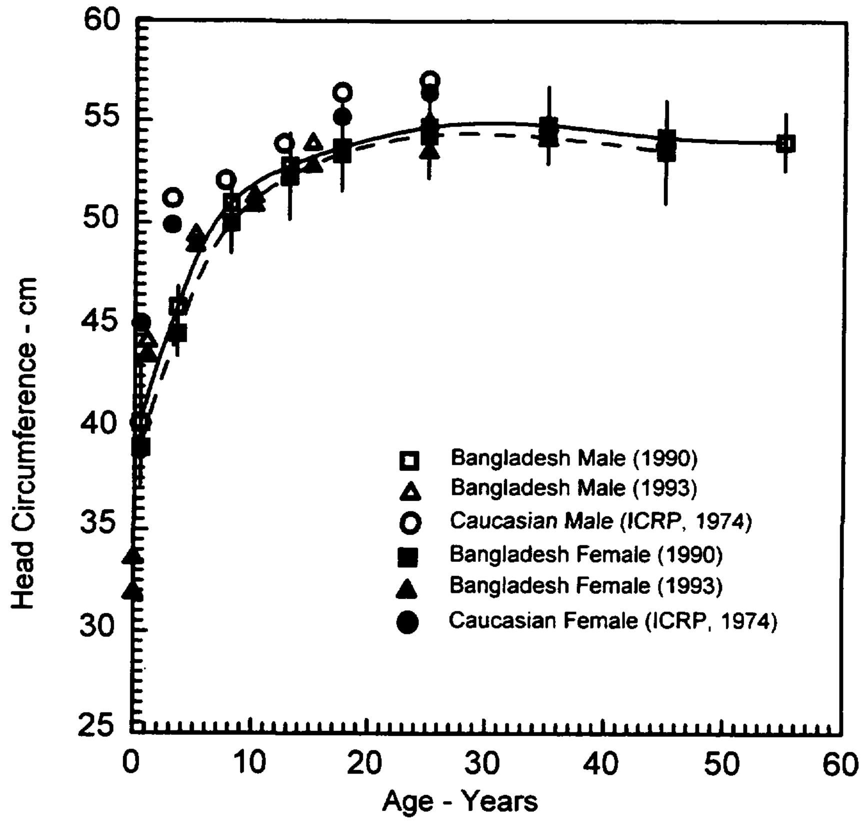

Fig 5 - Head circumference for Bangladeshi and Caucasian populations

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 (μg)	Fe (μg)	Cu (μg)	Zn (μg)	Sr (μg)
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 μg/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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STUDY ON THE SETTING OF REFERENCE CHINESE MAN

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Abstract

The procedures for internal and external dose estimation, the calculation of authorized limits and derived reference levels, and the development of phantoms in the field of radiation protection are based on values for the ICRP Reference Man. Many differences exist between Asians, Europeans and North Americans with respect to race, customs and the pattern of food consumption. The neglect of these differences in the parameters used may lead to errors in dose assessment and health effect prognosis. The research described in this paper was conducted to obtain reference values for the Chinese population or other Asian countries which might have major demographic contribution of Chinese. Based on the agreements reached in the Project Formulation Meeting "Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man", the measurement of physique, organ mass and the food consumption were given the first priority for the first phase of the project.

I. MEASUREMENT OF PHYSIQUE

Materials and Methods

Data from nine nationwide surveys on measurement of physique (height and weight of total body, sitting height, chest girth and head circumference, etc.) were collected and evaluated for this study. The methods used in sampling, measurement and statistic analysis were reviewed. The following four reports were chosen to provide the basic material for setting the reference values of height and weight of total body:

1) Survey of development of physique of children in nine cities of China (1985) [3];

2) Survey of development of physique of children under seven of age in countryside of 10 provinces of China (1985) [4];

3) Research of the constitution and health of Chinese students (1985) [5];

4) Human dimensions of Chinese adults (1985) [6].

Altogether about 920,000 persons covering 28 provinces of China were included in the analysis.

The average and standard deviation of height and weight of total body for both sexes of each age group were calculated (Figs 1,2). The 1985 data were compared with those from 1975 to obtain a 10 year secular trend of growth of height and weight of total body. The difference of the average for each age group between male and female, city dwellers and countryside dwellers and southerners and northerners were also analyzed.

Setting the reference values of height and weight of total body

In order to evaluate the public risk from environmental radiation contamination, the dose evaluation for general public is required. Reference Man parameter should be established for the general public as well as for occupational protection. Human anatomical, physiological and metabolic characteristics depend on age and sex, especially for those under 20 years old [11]. Therefore, a series of reference values for height and weight of total body should be set for both male and female at a range of ages, ie. 0, 3 months, 1, 5, 10, 15 and 20-50 years old.

The principles for setting the reference values of height and weight of total body are as follows:

1) The reference value should be close to the population average.

2) The average should be adjusted by the difference of demographic contribution between urban population and rural population, and by the secular trend of growth in height and weight of total body.

3) Because of the spread of value in any population, establishing reference values is not a precise process. Therefore, it is preferable to set these values to the nearest integer. Table 1 shows the reference values selected for height and weight of the Chinese population. The weighted averages were adjusted to account for the differences between the urban and rural demographic contributions [12]. The difference in column 6 reflect the secular growth trend from 1975 to 1985. The reference values were then based on the sum of the 1985 means and the 10 year secular trend in column 6. The last column shows the reference values selected for each age group. The reference values of height and weight for Chinese adult [20-30] are compared with those of Japanese [13] and ICRP Reference Man in Table 2.

II. MEASUREMENT OF ORGAN MASS

Materials and Methods

Data on the mass of internal organs were obtained from the results of autopsies performed by various medical facilities on sudden death victims. The data included 19,976 autopsies performed by 15 medical colleges in China 1950-1990 [14]. These data were combined with organ mass data for 4,070 adults collected by China Institute for Radiation Protection [15,16] and 1,000 autopsies of children by Capital Institute of Children [17]. The average of weight of 12 internal organs (adrenal glands, brain, heart, kidney, liver, lung, pancreas, pituitary, spleen, testes, thymus, thyroid) were calculated for both sexes and various age groups (Tables 3-12).

Setting the organ weight reference values

The reference value of organs were proposed according to the same principles as for setting the reference values of height and weight of total body (Table 1). The reference values of Chinese adult organ mass were compared with those of Japanese and ICRP Reference Man as shown in Table 13.

Text cont. on p. 23

TABLE I. REFERENCE VALUES FOR HEIGHT AND WEIGHT OF NORMAL CHINESE

	Sex	Age	City dwellers				Countryside dwellers				Weighted average		Difference	Reference value
			1985		1975		1985		1975		1985	1975		
			X	SD	X	SD	X	SD	X	SD	X	X		
Height (cm)	Male	Newborn	50 3	1 6	50 6	1 9	50 2	1 8	50 2	1 7	50 2	50 3	-0 1	50 0
		3 month	62 3	2 4	62 3	2 5	61 3	2 5	61 5	2 7	61 7	61 6	0 1	62 0
		1 year	76 3	2 8	75 6	3 1	74 4	3 1	73 7	3 1	75 0	74 0	1 0	76 0
		5 years	108 2	4 4	107 2	4 6	104 1	4 5	103 9	4 7	105 6	104 4	1 2	107 0
		10 years	135 5	5 9	134 4	5 9	131 5	5 9	129 7	5 6	133 0	130 5	2 5	136 0
		15 years	164 8	6 8	162 0	7 4	159 8	7 3	156 5	7 6	161 6	157 5	4 1	166 0
		20-30 yrs	169 3	5 9	169 3	5 7	167 1	5 5	165 8	6 0	167 9	166 5	1 4	170 0
		20-50 yrs	168 9	5 9	168 7	6 0	166 6	5 5	165 4	5 2	167 4	166 0	1 4	169 0
	Female	Newborn	49 7	1 6	50 0	1 8	49 5	1 7	49 7	1 2	49 6	49 8	-0 2	50 0
		3 months	60 9	2 2	60 9	2 4	59 9	2 4	60 1	2 6	60 3	60 2	0 1	60 0
		1 year	74 9	2 8	74 1	3 0	72 9	3 8	72 3	3 2	73 6	72 6	1 0	75 0
		5 years	107 3	4 3	106 5	4 4	103 2	4 6	102 0	4 5	104 7	102 8	1 9	107 0
		10 years	136 3	6 5	134 8	6 4	131 3	6 6	129 2	6 0	133 1	130 2	2 9	136 0
		15 years	156 8	5 3	155 5	5 6	154 1	5 2	153 0	5 6	155 1	153 4	1 7	157 0
		20-30 yrs	158 2	5 3	157 8	5 2	156 3	5 0	155 9	5 5	157 6	156 2	1 4	160 0
		20-50 yrs	157 8	5 3	156 9	5 4	155 8	5 8	155 5	5 5	156 6	155 7	0 9	158 0
Weight (Kg)	Male	Newborn	3 2	0 4	3 3	0 4	3 2	0 4	3 2	0 4	3 2	3 2	0 0	3 0
		3 months	6 7	0 8	6 7	0 8	6 5	0 8	6 5	0 9	6 6	6 5	0 1	7 0
		1 year	9 7	1 0	9 7	1 1	9 1	1 0	9 0	1 2	9 4	9 1	0 3	10 0
		5 years	17 2	2 0	16 9	1 8	16 2	1 7	16 1	1 6	16 6	16 2	0 4	17 0
		10 years	28 2	4 2	27 2	3 5	26 6	3 4	26 0	3 0	27 2	26 2	1 0	28 0
		15 years	50 0	6 9	46 9	6 5	47 3	6 8	43 6	5 5	48 3	44 2	4 1	52 0
		20-30 yrs	58 7	7 0	59 8	6 1	58 2	5 2	57 9	6 0	58 4	58 2	0 2	60 0
		20-50 yrs	59 0	7 3	60 0	7 0	58 5	5 3	58 2	6 1	58 7	58 5	0 2	60 0
	Female	Newborn	3 1	0 3	3 2	0 4	3 1	0 4	3 2	0 4	3 1	3 2	-0 1	3 0
		3 months	6 2	0 7	6 2	0 8	6 8	0 7	6 0	0 8	6 1	6 0	0 1	6 0
		1 year	9 1	1 0	9 0	1 0	8 5	1 0	8 4	1 0	8 7	8 5	0 2	9 0
		5 years	16 6	1 8	16 5	1 7	15 7	1 7	15 6	1 6	16 0	15 8	0 2	16 0
		10 years	28 1	4 4	27 1	3 6	26 2	3 8	25 4	3 2	26 9	25 7	1 2	28 0
		15 years	46 5	5 6	45 4	5 6	46 2	5 4	43 8	5 5	46 3	44 1	2 2	48 0
		20-30 yrs	50 5	6 2	52 8	5 8	51 4	5 3	52 6	5 5	51 1	52 6	-1 5	52 0
		20-50 yrs	51 4	6 9	54 0	4 1	52 5	5 4	52 7	6 0	52 1	52 9	-0 8	52 0

TABLE II. REFERENCE VALUES OF HEIGHT AND WEIGHT OF CHINESE COMPARED WITH THOSE OF JAPANESE AND ICRP

	Height (cm)		Weight (Kg)	
	Male	Female	Male	Female
The present paper	170	160	60	52
ICRP	170	160	70	60
Japanese	170	160	60	52
Zingshan Zhang et al	169	158	60	54

TABLE III. AVERAGE WEIGHT OF NORMAL CHINESE HEART BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	489	22 1	8 4	0 7	263	21 5	7 0	0 7
1 month	47	28 3	10 7	0 7	21	30 4	12 0	0 8
3 months	88	36 1	9 9	0 7	49	32 7	9 0	0 6
7 months	70	44 6	14 9	0 6	54	40 5	12 4	0 6
1 year	341	59 5	48 0	0 7	304	49 7	11 1	0 6
3 years	158	73 8	25 5	0 6	134	67 9	16 1	0 6
5 years	200	99 6	24 0	0 6	164	97 0	55 3	0 6
10 years	105	152 5	48 6	0 5	55	141 9	38 6	0 6
15 years	206	258 7	55 0	0 5	100	231 0	48 3	0 5
20 years	924	291 1	51 3	0 4	461	249 1	43 1	0 5
30 years	705	302 5	55 2	0 5	279	268 0	51 0	0 5
40 years	484	308 7	58 2	0 5	144	283 7	62 3	0 5
50 years	217	315 9	66 4	0 5	85	287 7	69 3	0 5
60 years	88	361 8	79 3	0 6	52	306 4	61 2	0 6

TABLE IV. AVERAGE WEIGHT OF NORMAL CHINESE LUNGS BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	146	61 4	22 0	2 1	68	56 5	17 8	2 0
1 month	18	86 2	42 8	2 0	5	80 6	27 0	1 8
3 months	23	115 4	39 5	1 9	17	121 1	48 8	2 2
7 months	20	140 2	43 6	1 8	13	141 2	43 7	1 9
1 year	108	207 7	167 3	2 1	116	187 1	63 9	2 2
3 years	64	295 7	329 6	2 4	54	241 8	76 5	1 9
5 years	107	362 0	120 4	2 2	86	354 3	124 6	2 1
10 years	64	564 2	228 7	2 1	35	472 6	189 7	1 8
15 years	78	941 6	435 3	1 6	39	769 3	232 5	1 8
20 years	336	998 3	295 9	1 6	204	829 5	229 3	1 5
30 years	271	1084 2	326 2	1 6	130	861 5	234 6	1 7
40 years	194	1112 9	366 1	1 9	62	835 7	234 9	1 6
50 years	117	1138 4	330 2	1 9	44	872 3	314 3	1 7
60 years	68	1242 1	268 7	2 1	42	924 4	223 6	1 8

TABLE V AVERAGE WEIGHT OF NORMAL CHINESE SPLEEN BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	546	11 9	8 1	0 40	277	11 3	5 7	0 40
1 month	54	20 7	11 1	0 50	23	18 1	7 5	0 50
3 months	93	25 6	9 6	0 50	53	20 5	6 4	0 40
7 months	69	30 0	11 2	0 40	53	30 0	12 7	0 40
1 year	328	45 1	22 9	0 50	308	39 7	17 2	0 50
3 years	154	56 4	23 8	0 40	137	48 9	24 6	0 40
5 years	214	78 9	75 4	0 40	168	65 3	28 4	0 40
10 years	111	106 7	49 0	0 40	61	94 4	44 0	0 40
15 years	153	161 7	73 3	0 30	91	150 6	67 5	0 40
20 years	734	175 0	73 5	0 30	384	149 7	68 6	0 30
30 years	669	168 6	84 5	0 30	246	156 8	67 3	0 30
40 years	564	157 7	83 0	0 30	164	133 0	48 5	0 30
50 years	295	144 8	60 9	0 30	103	119 4	61 3	0 20
60 years	162	153 9	80 4	0 30	93	113 8	75 1	0 20

TABLE VI AVERAGE WEIGHT OF NORMAL CHINESE LIVER BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	547	114 8	61 9	3 8	283	115 3	37 9	3 9
1 month	53	164 7	67 0	3 9	23	146 3	30 9	4 0
3 months	92	198 6	46 0	3 5	53	194 5	64 1	3 5
7 months	69	266 5	64 0	3 4	55	256 5	70 9	3 5
1 year	323	370 9	127 6	4 1	302	341 6	89 3	4 0
3 years	158	497 0	123 6	3 9	138	468 8	129 5	4 0
5 years	220	635 6	159 7	3 7	166	624 4	315 7	4 0
10 years	108	885 9	234 5	3 4	66	943 2	955 2	3 8
15 years	179	1249 4	255 0	2 5	92	1233 0	273 1	2 8
20 years	972	1359 7	232 8	2 3	439	1271 6	248 2	2 4
30 years	819	1359 4	234 1	2 3	295	1296 1	250 9	2 5
40 years	669	1350 9	234 7	2 3	180	1249 4	247 3	2 4
50 years	330	1316 8	255 8	2 3	115	1230 7	243 1	2 4
60 years	168	1225 8	270 3	2 1	94	1076 9	290 4	2 1

TABLE VII. AVERAGE WEIGHT OF NORMAL CHINESE KIDNEYS BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	539	28 1	10 8	0 9	282	27 7	11 3	0 9
1 month	51	47 3	39 0	1 2	22	35 8	11 6	0 9
3 months	93	50 3	16 9	1 0	57	45 6	18 6	0 8
7 months	71	61 3	15 9	0 8	58	57 1	20 8	0 8
1 year	371	76 0	23 5	0 9	324	70 8	18 9	0 8
3 years	162	93 0	32 6	0 8	146	89 4	24 8	0 8
5 years	215	122 9	30 8	0 7	172	120 2	36 3	0 7
10 years	107	172 0	45 6	0 7	70	168 6	48 4	0 6
15 years	217	253 0	53 9	0 5	105	242 1	46 7	0 6
20 years	1026	276 7	56 7	0 5	452	257 3	51 2	0 5
30 years	795	281 9	57 8	0 5	300	266 3	52 0	0 5
40 years	619	279 3	57 9	0 5	180	256 8	50 9	0 5
50 years	314	275 8	59 8	0 5	108	250 4	52 9	0 5
60 years	163	269 9	62 5	0 5	93	232 6	56 1	0 4

TABLE VIII. AVERAGE WEIGHT OF NORMAL CHINESE BRAIN BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	288	398 0	408 0	13 1	151	415 6	554 2	13 8
1 month	31	545 7	563 9	13 4	11	505 3	534 1	14 0
3 months	54	706 5	725 4	13 3	26	611 9	634 0	11 6
7 months	48	812 9	853 2	10 5	41	791 5	810 2	10 7
1 year	241	1024 6	1035 9	11 4	232	950 7	964 0	11 2
3 years	77	1219 8	1232 5	9 0	72	1126 7	1139 1	9 1
5 years	97	1293 8	1312 5	7 8	82	1182 5	1194 2	7 4
10 years	51	1388 0	1392 0	5 3	25	1300 6	1298 2	5 5
15 years	96	1446 6	144 1	3 0	50	1306 6	111 9	3 6
20 years	582	1439 8	135 4	3 0	267	1296 8	150 0	2 5
30 years	555	1434 1	144 3	2 5	193	1314 7	121 3	2 5
40 years	399	1424 7	149 3	2 5	97	1340 8	307 0	2 6
50 years	79	1400 2	120 5	2 4	66	1272 4	163 8	2 5
60 years	79	1355 0	188 6	2 3	38	1228 7	219 3	2 4

TABLE IX. AVERAGE WEIGHT OF NORMAL CHINESE PANCREAS BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	382	4 4	3 2	0 2	205	4 3	2 3	0 2
1 month	33	6 9	3 4	0 2	14	6 6	2 1	0 2
3 months	59	10 1	11 8	0 2	41	9 2	3 8	0 2
7 months	49	11 6	4 5	0 1	39	11 2	5 5	0 2
1 year	288	21 0	30 1	0 2	252	17 7	7 0	0 2
3 years	124	31 0	31 0	0 2	100	27 4	13 9	0 2
5 years	171	39 5	14 3	0 2	130	41 8	55 1	0 3
10 years	87	56 2	20 6	0 3	52	49 4	15 3	0 2
15 years	146	88 4	25 2	0 2	58	84 8	31 2	0 2
20 years	741	104 8	28 2	0 2	319	98 9	26 2	0 2
30 years	573	110 0	30 0	0 2	218	99 8	28 9	0 2
40 years	462	110 7	30 1	0 2	136	95 5	29 0	0 2
50 years	226	107 8	30 9	0 2	94	92 8	24 2	0 2
60 years	119	109 8	63 7	0 2	69	100 2	82 1	0 2

TABLE X. AVERAGE WEIGHT OF NORMAL CHINESE ADRENALS BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	SD	(%)	n	X	SD	(%)
< 1 month	739	7 3	3 3	0 2	457	7 2	3 2	0 2
1 month	269	5 7	2 7	0 2	152	5 2	2 3	0 2
3 months	221	4 9	2 0	0 7	166	4 8	2 2	0 8
7 months	397	5 0	2 1	0 6	305	5 0	1 9	0 6
1 year	713	5 2	2 2	0 6	591	5 4	2 8	0 6
3 years	350	6 4	3 9	0 5	304	6 1	3 3	0 5
5 years	398	7 5	4 1	0 4	298	7 3	3 9	0 4
10 years	210	9 8	4 8	0 3	121	10 0	4 7	0 4
15 years	81	12 6	4 5	0 2	65	14 2	5 3	0 3
Adult	2722	14 7	5 7	0 2	1303	14 3	6 2	0 3

TABLE XI AVERAGE WEIGHT OF NORMAL CHINESE THYROID BY SEX AND AGE - (g)

Age	Male			Fraction of Body Weight	Female			Fraction of Body Weight
	n	X	80% normal range	(%)	n	X	80% normal range	(%)
< 1 month	362	2 3	1 1-3 9	0 08	205	2 3	1 1-4 3	0 08
1 month	157	1 9	1 1-3 1	0 06	87	2 1	1 1-3 4	0 07
3 months	177	2 6	1 2-4 4	0 04	145	2 3	1 6-3 7	0 04
7 months	218	2 6	1 5-4 0	0 04	207	2 5	1 3-4 1	0 03
1 year	544	3 3	1 7-5 3	0 03	486	3 1	1 6-5 1	0 03
3 years	265	4 3	2 3-6 4	0 03	190	4 4	2 5-6 9	0 03
5 years	347	6 4	3 1-10 2	0 04	247	5 7	3 4-8 7	0 04
10 years	157	9 7	4 9-16 2	0 05	104	9 9	5 0-16 5	0 05
15 years	69	12 3	7 0-19 9	0 02	45	13 1	7 6-19 5	0 03
Adult	913	27 4	10 7-55 8	0 05	401	26 6	10 1-33 5	0 04

TABLE XII SECULAR TREND IN ORGAN WEIGHT OF ADULT CHINESE - (g)

Organs	Before 1970		After 1970		Difference	
	Male	Female	Male	Female	Male	Female
Heart	286 6	248 2	309 1	254 2	22 5	6 0
Lungs	956 1	806 1	1140 1	939 3	184 0	133 2
Spleen	164 1	145 6	199 0	170 0	35 0	24 4
Liver	1349 8	1270 3	1411 1	1279 4	61 3	9 1
Kidneys	275 8	258 8	280 4	249 5	4 6	9 3
Brain	1435 3	1294 5	1459 3	1309 3	24 0	14 8
Pancreas	103 7	98 7	112 6	100 4	8 9	1 7

The weights of liver and kidneys of the Chinese adult were less than those of Japanese and ICRP Reference Man. The weight of Chinese heart is less than that of Japanese Reference Man, but is the same as that of ICRP. The weight of pancreas of Chinese is less than that of Japanese, but greater than that of ICRP Reference value. The weight of brain and adrenals of Chinese adult are similar with those of both Japanese and ICRP Reference Man. The weight of lungs, spleen, thyroid, thymus, pituitary and testes are all greater than the Japanese and ICRP reference values. The weight differences of brain, heart and lungs between male and female are smaller for Chinese compared with those of Japanese and ICRP Reference Man The relative weight of brain, lungs, spleen, thyroid and testes for Chinese adult are all greater than those for Japanese and ICRP Reference Man (Table 13)

TABLE XIII. TOTAL AND FRACTIONAL ORGAN WEIGHT PROPOSED FOR REFERENCE CHINESE MAN COMPARED WITH JAPANESE AND ICRP REFERENCE MAN

Organs	Reference Chinese Man				Japanese Reference Man				ICRP Reference Man			
	Male		Female		Male		Female		Male		Female	
	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%
Brain	1480	2.5	1320	2.5	1500	2.5	1300	2.5	1400	2.0	1200	2.0
Heart	330	0.55	260	0.50	400	0.67	280	0.54	330	0.47	240	0.40
Kidneys	290	0.48	250	0.48	320	0.53	280	0.54	310	0.44	275	0.46
Liver	1470	2.5	1300	2.5	1600	2.7	1400	2.7	1800	2.6	1400	2.3
Lungs	1320	2.2	1070	2.1	1100	1.8	900	1.7	1000	1.4	800	1.3
Pancreas	120	0.20	102	0.20	130	0.22	110	0.21	100	0.14	85	0.14
Spleen	220	0.37	190	0.32	140	0.23	120	0.23	180	0.26	150	0.25
Adrenals	14	0.023	14	0.027	14	0.023	13	0.025	14	0.020	14	0.023
Thyroid	27	0.045	27	0.052	19	0.032	17	0.033	20	0.029	17	0.028
Thymus	36	0.060	28	0.054	33	0.055	25	0.048	20	0.029	20	0.033
Pituitary	0.8	0.0013	0.8	0.0015	0.6	0.0010	0.6	0.0012	0.6	0.00086	0.7	0.0012
Testes	56	0.093	-		37	0.062	-		35	0.050	-	
Total body	60000		52000		60000		52000		70000		60000	

TABLE XIV. THE DIFFERENCE BETWEEN MALE AND FEMALE DRY BONE WEIGHTS IN CHINESE ADULTS

Bone	Male (237)		Female (43)	
	Mean ± S.D.	% S.W.*	Mean ± S.D.	% S.W.*
Skull	576.0 ± 100.1	16.75	522.6 ± 122.0	21.05
Mandible	72.4 ± 16.0	2.11	55.2 ± 12.2	2.22
Clavicle (2)	38.3 ± 10.6	1.11	26.3 ± 7.1	1.06
Scapula (2)	101.2 ± 23.0	2.94	65.9 ± 13.4	2.65
Rib (2)	235.1 ± 59.8	6.84	163.7 ± 40.9	6.59
Sternum	16.4 ± 4.7	0.48	10.7 ± 2.5	0.43
Vertebral column	291.0 ± 64.3	8.46	228.0 ± 48.6	9.18
Humerus (2)	223.9 ± 51.4	6.51	138.4 ± 33.0	5.57
Ulna (2)	91.1 ± 20.0	2.65	59.1 ± 14.0	2.38
Radius (2)	74.1 ± 17.8	2.15	47.8 ± 12.5	1.93
Hands (2)	96.7 ± 22.2	2.81	70.3 ± 15.9	2.83
Innominates (2)	282.5 ± 71.1	8.21	201.2 ± 53.9	8.10
Sacrum	65.5 ± 15.6	1.90	49.4 ± 12.2	1.99
Femur (2)	615.7 ± 131.2	17.90	402.5 ± 95.0	16.21
Patella (2)	20.7 ± 4.7	0.60	13.5 ± 3.6	0.54
Tibia (2)	353.6 ± 82.3	10.28	255.7 ± 57.4	9.09
Fibula (2)	84.8 ± 20.4	2.47	57.9 ± 15.9	2.33
Feet (2)	204.3 ± 49.1	5.94	128.6 ± 32.6	5.18
Total	3438.0 ± 633.4	100.00	2482.6 ± 488.6	100.00

* Percentage of the total skeleton weight

TABLE XV. THE DIFFERENCES BETWEEN SOUTHERN AND NORTHERN REGIONS FOR DRY BONE WEIGHTS IN CHINESE ADULTS

Bone	Male (237)			Female (43)		
	South±SD	North±SD	S/N	South±SD	North±SD	S/N
Skull	548.6±101.9	595.0±91.9	0.92	509.9±138.0	544.1±54.1	0.94
Mandible	67.0±15.8	76.0±15.1	0.88	53.0±8.6	60.7±8.6	0.88
Clavicle (2)	33.0±9.4	41.6±10.3	0.79	25.6±7.3	30.2±6.5	0.85
Scapula (2)	88.5±23.5	109.6±18.2	0.81	63.4±14.5	71.7±8.3	0.88
Rib (2)	191.2±48.2	264.3±46.3	0.72	150.8±33.5	195.3±39.7	0.77
Sternum	15.2±5.4	17.1±4.0	0.89	10.3±1.9	11.3±3.0	0.91
Vertebral column	269.8±65.0	304.6±59.7	0.89	222.0±73.5	250.0±42.8	0.89
Humerus (2)	191.1±51.5	245.5±38.4	0.78	131.5±32.0	156.3±29.8	0.84
Ulna (2)	77.6±20.9	99.5±14.7	0.78	54.6±13.2	70.8±7.9	0.77
Radius (2)	61.9±16.7	81.9±13.8	0.76	44.3±12.7	57.1±6.2	0.78
Hands (2)	80.0±19.4	107.6±14.6	0.74	65.9±14.4	81.6±14.1	0.81
Innominates (2)	247.4±71.0	307.3±64.9	0.81	196.4±49.5	222.5±42.5	0.88
Sacrum	57.3±14.9	71.1±12.7	0.81	45.7±10.5	58.8±11.7	0.78
Femur (2)	527.7±13.0	670.6±100.9	0.79	384.5±93.4	451.7±79.1	0.85
Patella (2)	18.7±4.9	22.1±4.0	0.85	13.2±3.9	14.3±2.9	0.92
Tibia (2)	300.7±86.9	387.5±61.5	0.78	214.9±60.5	252.9±43.5	0.85
Fibula (2)	77.5±39.0	93.2±15.1	0.83	52.4±16.6	70.4±9.9	0.74
Feet (2)	165.9±41.0	229.2±36.4	0.72	119.8±25.3	149.6±30.8	0.80
Total	3011.3±600.1	3735.2±465.1	0.81	2379.4±503.1	2749.1±337.5	0.87

TABLE XVI. RELATIVE WEIGHTS OF DRY BONES AS PERCENTAGES OF THE TOTAL SKELETON OF CHINESE ADULTS

Bone	China (% S.W.*)		ICRP-23 (% S.W.*)	
	Male	Female	[Spiers, 1968]	[Ingalls, 1931]
Skull	16.75	21.05	16.60	-
Mandible	2.16	2.22	1.77	1.65
Clavicle (2)	1.11	1.06	1.00	1.08
Scapula (2)	2.94	2.65	3.02	3.12
Rib (2)	6.84	6.59	4.41	6.64
Sternum	0.48	0.43	0.30	0.65
Vertebral column	8.46	9.18	8.33	-
Humerus (2)	6.51	5.57	6.66	7.24
Ulna (2)	2.65	2.38	2.94	2.70
Radius (2)	2.15	1.93	2.42	2.18
Hands (2)	2.81	2.83	3.04	2.76
Innominates (2)	8.21	8.10	7.47	-
Sacrum	1.90	1.99	-	2.24
Femur (2)	17.90	16.21	17.76	18.44
Patella (2)	0.60	0.54	-	-
Tibia (2)	10.28	9.09	10.16	10.78
Fibula (2)	2.47	2.33	2.50	2.32
Feet (2)	5.94	5.18	11.64	6.18

* Percentage of the total skeleton weight.

TABLE XVII. THE WEIGHT OF SKELETON FOR CHINESE ADULTS AS COMPARED WITH THOSE OF JAPANESE AND ICRP

Sex	China		Japan		ICRP-23	
	S.M. (Kg)	% B.W.	S.M. (Kg)	% B.W.	S.M. (Kg)	% B.W.
Male	8.0* (North 8.5 South 6.9)	13.3	8.3	13.8	10.0	14.3
Female	5.5* (North 5.9 South 5.1)	10.6	5.8	11.3	6.8	11.3

* Incl. Os hyoideum, Os coccygis and teeth
S.M. = skeleton weight
B.W. = body weight

III. MEASUREMENT OF SKELETON MASS

Materials and Methods

The skeleton of 237 male and 43 female of Chinese adults from north and south of China were collected. The dry weights of various bones were measured. The skeletal wet weights were then calculated by multiplying dry weight with the ratio of wet vs dry weight of skeleton from ICRP-23. These are 2.17 for male and 2.13 for female. There are significant differences in weight of various bones and the total skeleton weight between male and female, as well as between northerner and southerner (Tables 14,15). The relative dry weight of individual bones as percentage of the total Chinese skeleton are shown in Table 16.

Setting the reference value

Based on these data, the reference values proposed for total skeleton of Chinese adult are 8.0 Kg for male and 5.5 Kg for female. These are lower than those for ICRP Reference Man but close to those of Japanese. The relative weight of skeleton as percentage of total body weight are 13.3 for male and 10.6 for female (Table 17).

IV. FOOD CONSUMPTION AND NUTRIENT, ELEMENTS AND RADIONUCLIDES INTAKES OF CHINESE

Materials and Methods

The references used for this purpose are as follows:

1) The second of nationwide survey of nutrition of Chinese in 1982 [18];

2) Table of component of food (1989) [19];

3) Investigation of food radioactivity and estimation of internal dose by ingestion in China (1987) [20].

In the second nationwide survey of nutrition of Chinese in 1982, 172 sampling points were chosen for study (50 for city and 116 for countryside), covering 27 provinces of China. Thirty to fifty 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). A total of about 48,000 persons were surveyed. From the survey we obtained information on national average daily per capita food consumption patterns for 25 kinds of food. The national average daily intake per capita of 11 kinds of nutrient, 17 minor and trace elements, 17 radionuclides were also calculated based on the table of food components and the results of investigation of food radioactivity according to the following formula:

$$I_i = \sum_j C_{ij} D_j$$

I_i: daily intake of i element or radionuclide
C_{ij}: average concentration of i element or radionuclide in food j
D_j: daily consumption of food j

TABLE XVIII. FOOD CONSUMPTION PER CAPITA IN DIFFERENT COUNTRIES (Kg Wet/a)

Country	Grains	Potato & starch	Sugar & its crop	Beans & nuts	Veg	Fruit	Meat & poultry	Eggs	Aquatic product	Milk & product	Oil & fat
France	76 1	90 8	35 6	4 3	112 0	74 2	99 1	12 9	18 7	320 6	19 1
UK	74 6	90 4	48 6	4 9	60 5	47 1	73 5	13 8	7 9	363 6	15 1
USA	61 8	47 9	50 1	8 1	94 7	72 3	110 1	16 0	6 9	246 1	22 5
New Zealand	76 2	51 8	36 0	3 2	128 0	73 3	113 5	17 1	4 7	396 9	6 7
Japan	117 9	28 5	26 2	10 4	131 9	57 3	28 6	16 2	34 1	57 0	11 9
Brazil	90 8	69 0	43 5	26 8	22 0	131 9	30 9	4 0	4 8	49 7	8 2
India	136 0	10 6	24 5	19 5	46 7	23 3	1 5	0 1	2 3	33 8	4 5
China*	186 8	60 9		5 3	117 5	10 0	14 1	3 2	4 1	3 1	6 1

* Quoted from reference (2) data.

TABLE XIX. NATIONAL AVERAGE DAILY FOOD CONSUMPTION PER CAPITA, 1982 (g/day/person)

Food	Kindergarten (2-6 years)	Primary school (7-12 years)	Middle school (13-18 years)	Adult
Rice	107.8	120.4	204.5	208.0
Flour	99.0	254.3	288.9	198 0
Other cereals	4.3	8.6	71.6	92.0
Potatoes	15.3	34.8	70.1	163.0
Beans	7.2	15.4	3.7	9.6
Bean products	8.8	6.8	9.1	5.9
Green vegetables	89.3	122.9	237.4	232.0
Yellow vegetables	27.4	49.6	47.0	73.0
Dry vegetables	0	0	0	0.1
Salted vegetables	6.0	4.2	26.7	13 7
Fungi	0 7	0.4	0.9	1.0
Fruits	65 3	12.6	4 1	28.0
Nuts and seeds	1.9	0.3	1.3	2.0
Milk, milk products	35.4	14.0	3.3	9.0
Eggs	14 1	26.0	4.0	9.7
Meats	44.1	60.3	48.1	42 3
Fish, shellfish	9.8	22.2	3.4	11 8
Starches and sugar	16.9	4 3	5.0	8 6
Animal fats	2.3	15.6	10.8	6 0
Vegetable oils	3.7	0.6	4.4	3.7
Other oils	7 5	10.1	7.0	7.5
Soy sauces	8.3	15.5	14 0	12 8
Salt	4 0	5 7	9.0	11 2
Drinks	0.1	0.9	0	3.1
Other	13.4	5.2	5.6	9.4

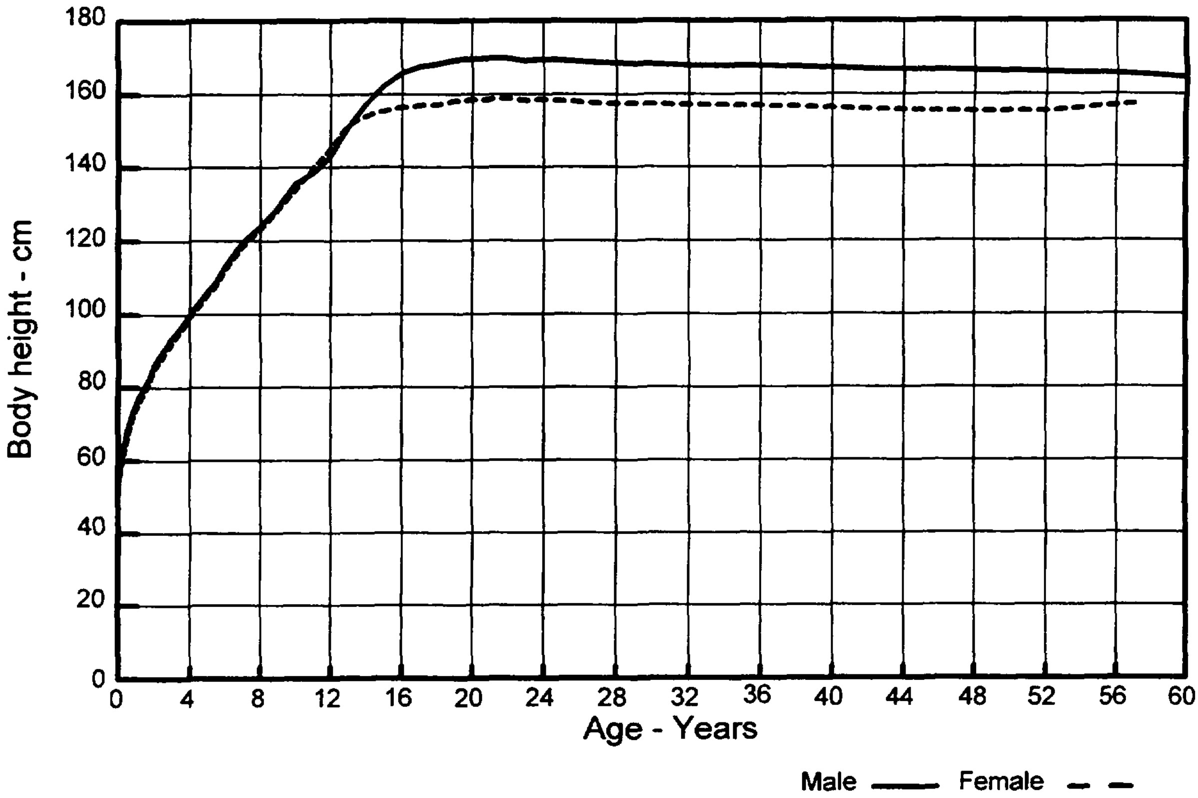

Fig. 1 - Total body height of Chinese

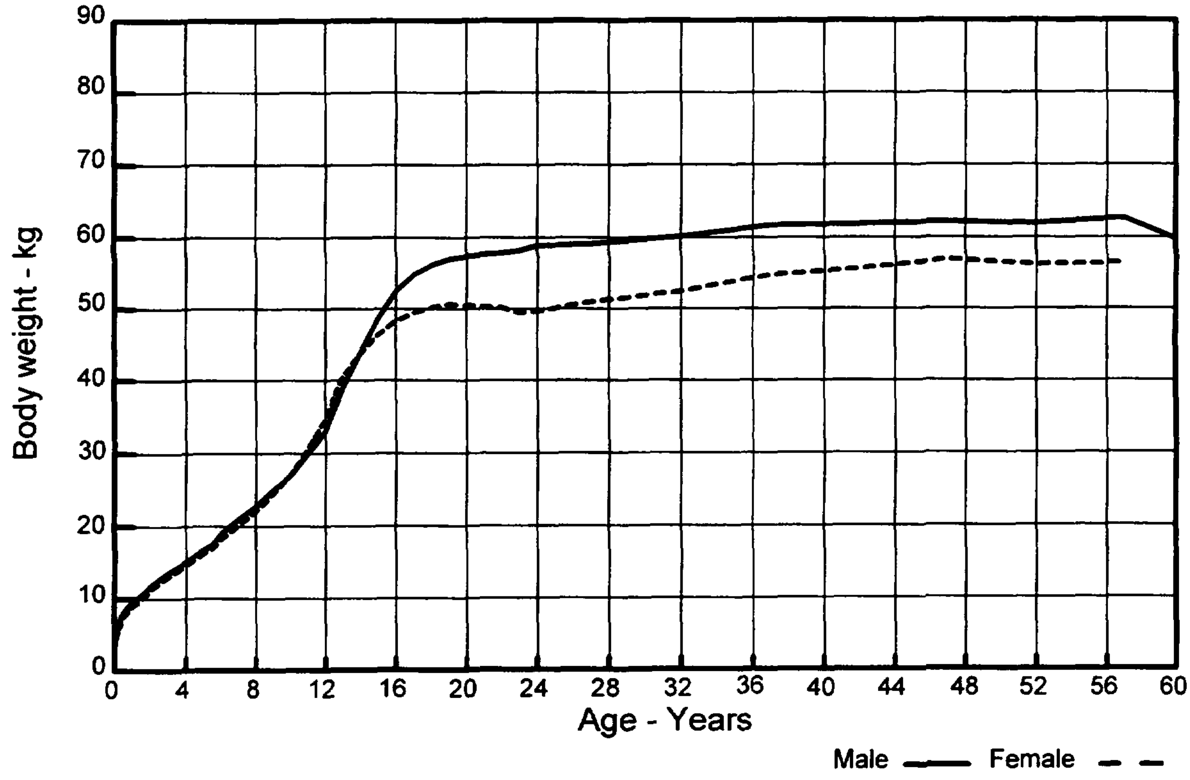

Fig. 2 - Total body weight of Chinese

Results

As shown in Table 18, the consumption of cereals was greater and the consumption of meats, eggs and milk was less for Chinese than those for Japanese, European and American Average daily consumption per capita of 25 kinds of food and average daily intake per capita of 11 nutrients for various age group of Chinese were shown in Tables 19,20. Only 5 4% of the caloric intake and 8.1% of the protein are obtained from animal food products for Chinese in 1982, compared with 30% and 50% respectively for developed countries. The intake of 17 elements and 17 radionuclides were calculated and compared with the values assumed by ICRP as shown in Tables 21,22. Chinese average daily intake of C,N,S,and Ca are less than those for ICRP Reference Man, while the intake of P,Fe,Na,Cl,Rb,Th and Mg are greater. These findings are related to the pattern of food consumption. For example, the lower intake of nitrogen and sulfur is due to less consumption of protein Consumption of less milk and more salt leads to diminished intake of Ca and greater intake of Na,Cl and Mg. For the radionuclide intakes the comparison indicated that the Chinese and ICRP values are similar

TABLE XX NATIONAL AVERAGE DAILY NUTRIENT INTAKE PER CAPITA, 1982

Nutrient	Kindergarten (2-6 years)	Primary school (7-12 years)	Middle school (13-18 years)	Adult
Protein (g)	38 1	57 6	67 2	66 0
Fat (g)	48 8	52 0	57 1	49 1
Carbohydrate (g)	203 7	308 0	439 5	432 7
Energy (calorie)	1404 0	1928 0	2534 0	2465 0
Cellulose (g)	3 3	4 6	6 9	7 7
Vitamin A (IU)	428 0	760 0	414 0	273 0
Carotene (mg)	0 9	1 3	1 6	3 5
Vitamin B1 (mg)	1 2	1 7	2 4	2 4
Vitamin B2 (mg)	0 5	0 7	0 7	0 9
Vitamin C (mg)	88 0	89 0	94 0	120 0
Nicotinic acid (mg)	9 0	14 0	20 0	17 0

TABLE XXI NATIONAL AVERAGE DAILY INTAKE OF ELEMENTS PER CAPITA, 1982

Elements	Chinese	ICRP
C (g)	260 8	310 3
N (g)	11 1	16 0
S (g)	0 8	1 1
Ca (g)	0 7	1 1
P (g)	1 6	1 4
Fe (mg)	35 8	16 0
Sr (mg)	1 5	1 9
Zn (mg)	12 2	13 0
La (g)	7×10^{10}	-
Ce (g)	5×10^{10}	-
Na (g)	5 7	4 4
Mg (g)	0 4	0 3
Cl (g)	10 1	5 2
U (g)	$1\ 2 \times 10^{-6}$	$1\ 9 \times 10^{-6}$
Th (g)	$4\ 0 \times 10^{-6}$	$3\ 0 \times 10^{-6}$
K (g)	2 6	3 3
Rb (mg)	4 2	2 2

TABLE XXII. NATIONAL AVERAGE DAILY INTAKE OF RADIONUCLIDES PER CAPITA, 1982 (Bq/day/person)

Radionuclides	Chinese	ICRP
238-U	1.5×10^{-2}	2.4×10^{-2}
234-U	1.6×10^{-2}	2.4×10^{-2}
235-U	7.0×10^{-4}	1.1×10^{-3}
232-Th	1.6×10^{-2}	1.2×10^{-2}
226-Ra	6.8×10^{-2}	8.5×10^{-2}
228-Ra	8.7×10^{-2}	-
210-Pb	2.0×10^{-1}	-
210-Po	1.8×10^{-1}	1.2×10^{-1}
227-Ac	8.9×10^{-4}	-
40-K	7.2 x 10	9.1 x 10
87-Rb	3.8	2.0
14-C	4.8 x 10	-
3-H	6.2	-
90-Sr	1.7×10^{-1}	-
137-Cs	1.1×10^{-1}	-
144-Ce	1.9×10^{-2}	-
106-Ru	2.0×10^{-2}	-

TABLE XXIII. NATIONAL AVERAGE FOOD CONSUMPTION (g/person/day) IN 1990 AS COMPARED WITH THAT IN 1982

Food	1990	1982
Cereals	461.4	498.0
Pulses	39.5	17.5
Potatoes	101.0	163.0
Meats	48.9	27.1
Eggs	17.1	9.7
Milk & Milk products	11.0	2.5
Fish & Shellfish	22.9	11.8
Vegetables	323.8	342.7
Fruits	101.1	29.3
Sugar & confectionery	3.3	4.4
Vegetable oils	22.5	11.5
Animal fats	5.8	4.4
Beverages & water	512.1	
Drink	14.0	3.8

Recent Chinese food consumption data

In the last ten years, the living standard of Chinese is much improved with the development of economy. A new Chinese Total Diet survey was carried out in 1990. The preliminary results are shown in Table 23, and compared with the corresponding figures for the 1982 survey. After eight years, the consumption of cereals, vegetables and salt were decreased, but the consumption of animal food (such as meat, eggs and milk products, aquatic products), pulses, oils, drink and fruits were much increased for Chinese. The intakes of energy, protein and fat come from animal food have been increased by 159.3%, 169.1% and 46.0% respectively. It is evident that the diet quality of Chinese is much improved and the composition of diet of Chinese is more balanced even though the plant foods are still the main sources of nutritional intake. The consumption of animal foods remain less than that for the western population (Table 24). Various nutritional intakes are close to the goal of WHO on nutrition (Table 25).

TABLE XXIV. NATIONAL AVERAGE NUTRITIONAL INTAKE IN 1990 AS COMPARED WITH THAT IN 1982

Nutrition	Mean	
	1990	1982
Energy (Kcal)	2203.3	2498.0
% from animal food	14.0	5.4
% from plant food	84.9	93.9
Protein (g)	64.0	66.0
% from animal food	21.8	8.1
% from beans	8.3	9.0
% from plant food	69.9	82.9
% of energy	11.6	10.5
Fats (g)	51.2	44.1
% from animal food	53.0	36.3
% from plant food	47.0	63.7
% of energy	21.2	16.0
Carbohydrate (g)	365.6	433.2
% of energy	66.1	70.8

TABLE XXV. NATIONAL AVERAGE NUTRITIONAL INTAKE OF CHINESE COMPARED WITH GOAL OF NUTRITION OF WHO

	Goal of nutrition of WHO		Average intake in Chinese (1990)
	Low limit	High limit	
Energy (Kcal)			2203.3
Fats (% of energy)	15.0	30.0	21.2
Saturate fatty acid	0.0	10.0	6.1
No saturate fatty acid	3.0	7.0	5.7
Cholesterol (mg/day)	0.0	300.0	178.6
Carbohydrate (% of energy)	55.0	75.0	66.1
Compound carbohydrate	50.0	70.0	
Cellulose (g/day)			
No-starch-polysaccharide	16.0	24.0	
Cellulose	27.0	40.0	26.6
Sugar (% of energy)	0.0	10.0	0.6
Protein (% of energy)	10.0	15.0	11.6
Salt (g/day)	-	6.0	13.9

TABLE XXVI-I. THE ELEMENTAL CONTENT OF ORGANS AND TISSUES IN NORMAL CHINESE (μg/g wet sample)

Organ and tissue	Element														
	Zn			Cu			Mn			Fe			Cr		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Stomach	45	18 67	4 50	47	1 363	0 481	46	0 675	0 306	46	40 21	20 58	41	0 223	0 175
Large	45	17 52	5 41	44	1 296	0 580	42	1 085	0 528	44	36 25	18 17	42	0 418	0 546
intestine	46	16 71	5 17	47	1 374	0 534	47	0 943	0 521	48	47 06	34 93	43	0 310	0 351
Small	47	22 24	3 84	49	2 833	0 813	49	0 508	0 208	49	67 98	25 95	49	0 547	0 639
intestine	51	43 53	11 13	49	8 268	5 643	52	1 520	0 589	51	218 4	136 8	43	0 239	0 220
Heart	53	16 61	3 00	50	0 955	0 317	53	0 357	0 181	51	211 6	112 0	44	0 238	0 202
Liver	51	13 35	6 27	52	1 031	0 499	52	0 597	0 416	51	193 7	122 4	51	0 569	0 455
Spleen	52	27 11	6 24	52	1 976	0 703	53	1 055	0 345	51	89 08	52 86	46	0 214	0 204
Lung	50	61 63	17 95	51	1 975	0 689	47	2 467	0 790	50	90 65	49 08	40	0 635	0 485
Kidneys	49	13 07	2 91	48	4 263	1 762	49	0 460	0 183	48	65 15	25 66	41	0 441	0 452
Skeleton*	8	12 85	7 58	8	0 620	0 340	8	0 570	0 490	8	48 59	44 77	5	0 214	0 200
Cerebrum	50	28 63	6 40	49	1 158	0 389	50	1 299	0 503	49	56 50	37 44	41	0 250	0 212
Thymus	48	16 43	4 81	49	1 482	0 562	47	0 754	0 397	45	83 16	40 67	37	0 298	0 202
Pancreas	48	20.96	5 04	51	0 799	0 262	47	0 467	0 217	50	50 83	27 46	41	0 193	0 113
Adrenal	44	18 91	8 47	44	2 259	1 027	40	0 978	0 443	40	96 05	48 59	40	1 206	0 985
gland	33	10 04	2 33	34	0 657	0 183	32	0 251	0 103	32	26 48	14 89	29	0 142	0 096
Thyroid	14	9 91	2 96	14	0 841	0 329	14	0 441	0 266	14	55 95	32 00	13	0 526	0 620
Pituitary															
Testes															
Ovary															

* Rib

Table XXVI-II. THE ELEMENTAL CONTENT OF ORGANS AND TISSUES IN NORMAL CHINESE ($\mu g/g$ wet sample)

Organ and tissue	Element														
	Ni			Co			Mo			Sr			K		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Stomach	43	0 167	0 163	45	0 009	0 006	47	0 049	0 023	44	0 222	0 108	46	1529 1	404 7
Large intestine	42	0 280	0 380	43	0 019	0 008	45	0 039	0 021	45	0 621	0 492	45	1334 3	478 4
Small intestine	42	0 208	0 198	45	0 012	0 009	46	0 046	0 017	46	0 342	0 235	46	1352 6	350 6
Heart	44	0 151	0 188	47	0 019	0 010	49	0 059	0 026	44	0 098	0 054	50	2157 0	469 0
Liver	43	0 101	0 119	51	0 036	0 016	51	0 951	0 359	48	0 100	0 053	50	2199 2	523 1
Spleen	45	0 117	0 110	52	0 010	0 008	49	0 022	0 017	47	0 111	0 056	53	2559 0	464 0
Lung	51	0 277	0 276	46	0 022	0 014	50	0 032	0 022	52	0 265	0 162	52	1879 6	402 4
Kidneys	50	0 163	0 184	53	0 013	0 107	52	0 221	0 075	51	0 140	0 082	51	1997 0	374 0
Skeleton*	47	1 822	1 121	48	0 043	0 032	46	0 284	0 260	52	56 92	22 69	49	1392 0	411 0
Cerebrum	43	0 314	0 367	49	0 011	0 012	48	0 040	0 020	49	0 105	0 086	49	2370 5	555 1
Thymus	5	0 155	0 118	5	0 037	0 027	8	0 049	0 042	8	0 455	0 369	8	1579 3	804 6
Pancreas	45	0 169	0 221	48	0 016	0 023	47	0 084	0 049	47	0 147	0 080	48	2398 5	446 2
Adrenal gland	43	0 360	0 400	47	0 015	0 012	48	0 138	0 053	46	0 171	0 116	49	1819 3	487 6
Thyroid	41	0 113	0 094	49	0 012	0 008	51	0 043	0 030	46	0 227	0 084	50	1689 1	391 0
Pituitary	38	0 427	0 450	39	0 056	0 056	44	0 082	0 222	44	0 484	0 222	44	1547 4	680 8
Testes	34	0 203	0 373	27	0 007	0 006	34	0 035	0 014	33	0 092	0 041	34	1867 2	366 2
Ovary	13	0 392	0 521	12	0 008	0 007	14	0 032	0 015	12	0 190	0 101	14	1499 0	299 2

* Rib

TABLE XXVI-III. THE ELEMENTAL CONTENT OF ORGANS AND TISSUES IN NORMAL CHINESE (μg/g wet sample)

Organ and tissue	Element														
	Na			Ca			Mg			Cd			Pb		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Stomach	47	1392.6	435.4	47	25.87	14.05	47	147.13	50.78	46	0.185	0.083	45	0.064	0.058
Large intestine	46	1512.0	673.2	44	27.01	14.99	44	195.50	104.02	43	0.168	0.110	42	0.059	0.036
Small intestine	48	1788.2	556.8	45	23.92	11.65	46	153.91	63.13	44	0.249	0.149	44	0.050	0.064
Heart	50	1233.0	432.0	50	18.14	12.00	50	184.50	63.20	49	0.547	0.693	43	0.050	0.040
Liver	52	1189.6	355.7	51	21.02	12.78	51	178.48	51.52	43	0.239	0.220	44	0.164	0.091
Spleen	53	1032.0	334.0	52	22.69	13.01	52	155.20	46.20	50	0.207	0.104	49	0.097	0.060
Lung	53	1415.9	539.2	53	24.61	15.24	53	118.85	52.05	50	0.257	0.202	50	0.098	0.075
Kidneys	51	1419.0	380.0	52	20.93	9.92	52	140.30	40.30	46	5.300	2.724	45	0.092	0.050
Skeleton*	51	3135.0	866.0	47	71128	26516	51	1657.0	802.0	52	2.204	0.600	48	0.353	0.361
Cerebrum	48	1275.6	357.3	49	19.24	10.24	48	137.14	45.10	45	0.106	0.041	46	0.051	0.031
Thymus	8	1242.2	637.2	8	285.9	41.25	8	131.02	69.47	7	0.092	0.042	7	0.047	0.026
Pancreas	50	1271.4	336.6	49	25.00	12.81	50	181.49	73.47	46	0.399	0.221	46	0.109	0.079
Adrenal gland	48	1344.8	519.3	48	34.89	22.00	48	125.20	34.44	46	0.247	0.185	46	0.111	0.081
Thyroid	50	1706.0	503.2	49	64.26	31.09	51	97.64	38.22	48	0.303	0.163	46	0.022	0.029
Pituitary	41	1843.9	563.4	43	106.0	66.99	45	143.67	67.75	39	0.828	0.199	45	0.409	0.331
Testes	36	1134.7	471.1	34	17.85	9.73	35	104.60	25.25	24	0.142	0.096	31	0.037	0.029
Ovary	14	1367.0	52.57	14	21.47	12.00	14	114.22	39.15	12	0.117	0.058	11	0.031	0.018

* Rib

TABLE XXVII. SUMMARY OF ELEMENTAL CONCENTRATIONS FOR VARIOUS ORGANS AND TISSUES IN NORMAL CHINESE COMPARED WITH THOSE OF INDIA, JAPAN AND REPORTED BY THE ICRP

Element	Organ or Tissue	Comparative Results A:B	Relative concentrations - A/B
1. Zn	Thyroid		1.5
Pb	Bone, Liver	China < ICRP	31.0, 10.5
Cd	Kidney		6.0
Fe	Lung		1.9
2. Ni	Heart		3.2
Zn	Adrenal, Thymus	China > ICRP	2.1, 2.0
Mn, Mo	Bone		4.7, 6.0
Cr	All Tissues		1.3 - 147
3. Cu	Adrenal	India > China	3.0
Pb	Kidney		174.
4. Ca	Multiple Tissues*	Japan > China	2.0 - 8.0
Sr	Multiple Tissues*	Japan < China	1.5 - 5.0
Cd	Kidney, Liver and Pancreas	Japan > China	3.5, 40.5, 13.5

* Heart, Liver, Spleen, Kidney, Cerebrum and Pancreas

TABLE XXVIII. THE VALUES OF PULMONARY FUNCTION TEST IN HEALTHY ADULTS (M ± SD)

Items	Male	Female
VC	4.087 ± 0.678	2.956 ± 0.508
IC	2.578 ± 0.491	1.895 ± 0.375
ERV	1.511 ± 0.437	1.072 ± 0.356
FRC	3.112 ± 0.611	2.348 ± 0.479
RV	1.615 ± 0.397	1.245 ± 0.336
TLC	5.766 ± 0.782	4.353 ± 0.644
RV/TLC**	28.011 ± 5.619	28.792 ± 6.773
FVC	3.977 ± 0.692	2.886 ± 0.547
FEV_1	3.285 ± 0.652	2.486 ± 0.531
$FEV_1\%$	82.673 ± 6.505	85.917 ± 6.418
MMEF	3.452 ± 1.160	2.836 ± 0.945
$\dot{V}_E$	6.628 ± 1.688	5.648 ± 1.466
MBC	116.423 ± 27.313	83.307 ± 20.149
BR	94.058 ± 2.122	92.963 ± 2.501
PEF	7.126 ± 1.364	5.428 ± 1.151
$\dot{V}_{75}$	5.860 ± 1.290	4.750 ± 0.983
$\dot{V}_{50}$	3.424 ± 1.053	2.950 ± 0.887
$\dot{V}_{25}$*	1.325 ± 0.658	1.152 ± 0.689
$\dot{V}_{50}/\dot{V}_{25}$**	2.937 ± 1.072	3.149 ± 1.374
D_LCO_{SB}	25.204 ± 5.887	17.815 ± 3.691

** P>0.05
* P<0.05
Rest P<0.01

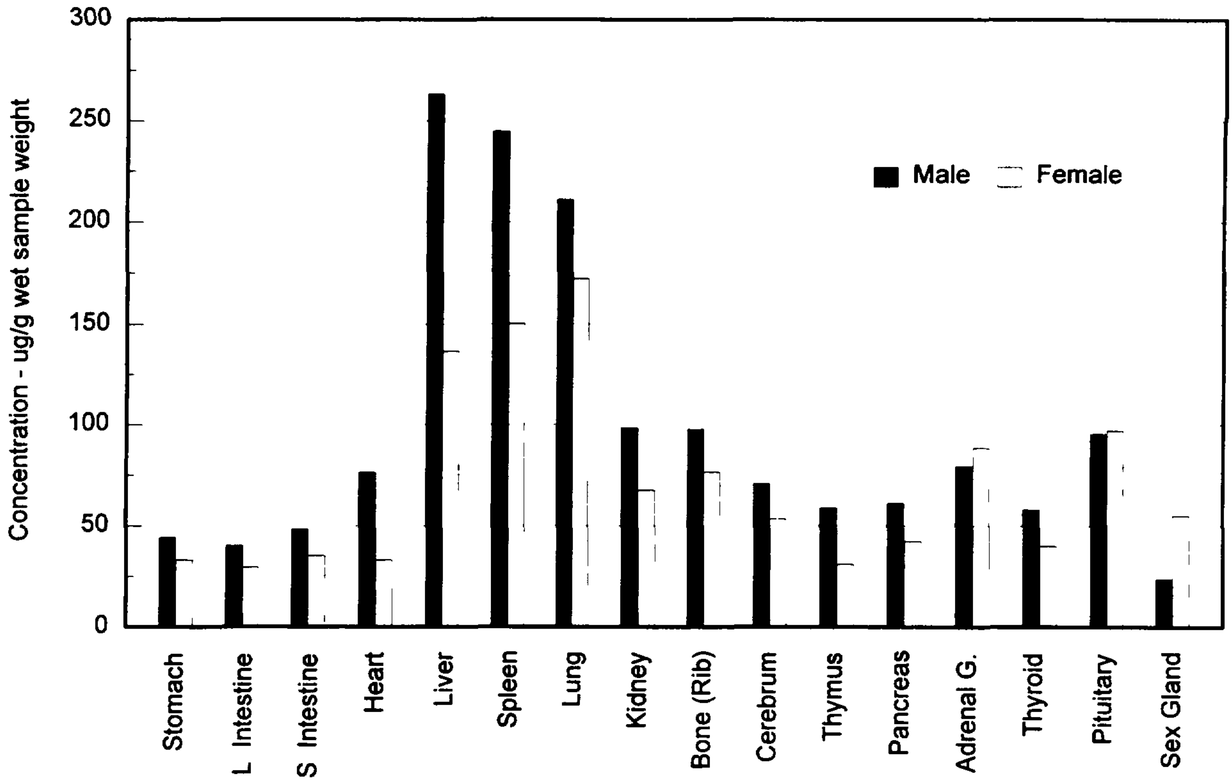

Fig. 3 - Fe concentration in various organs

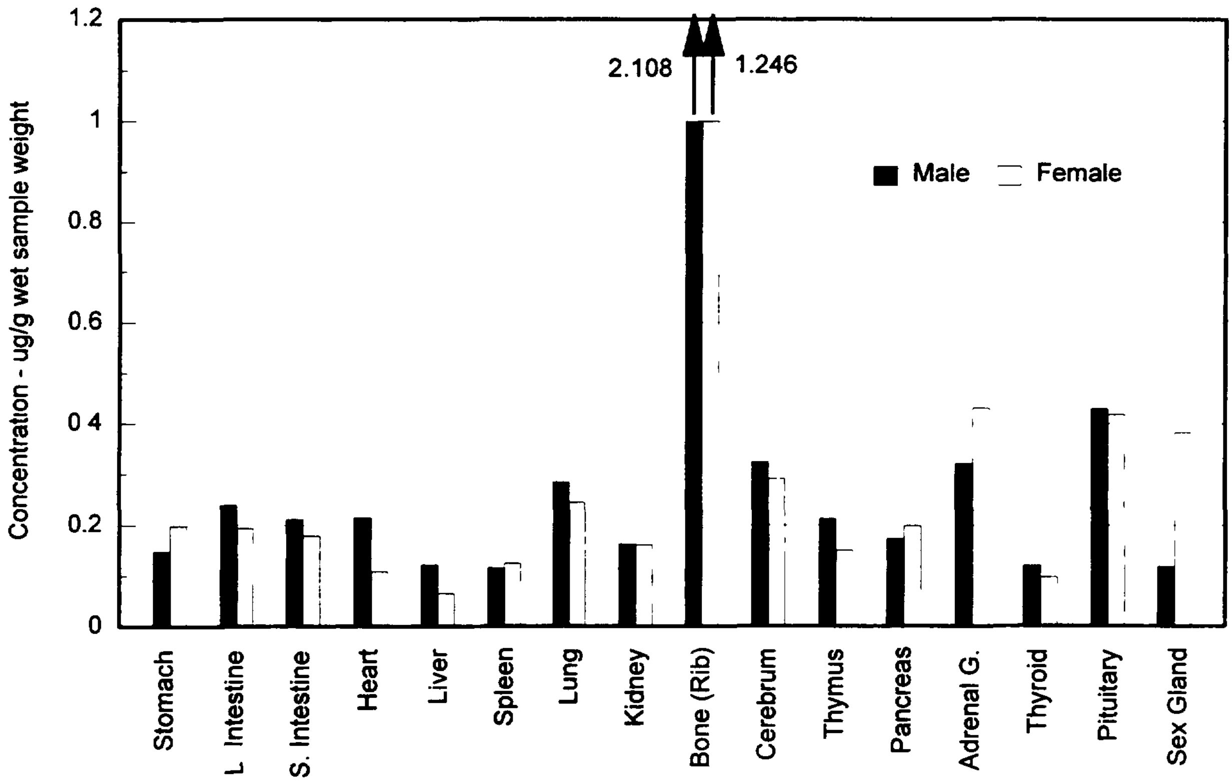

Fig. 4 - Ni concentration in various organs

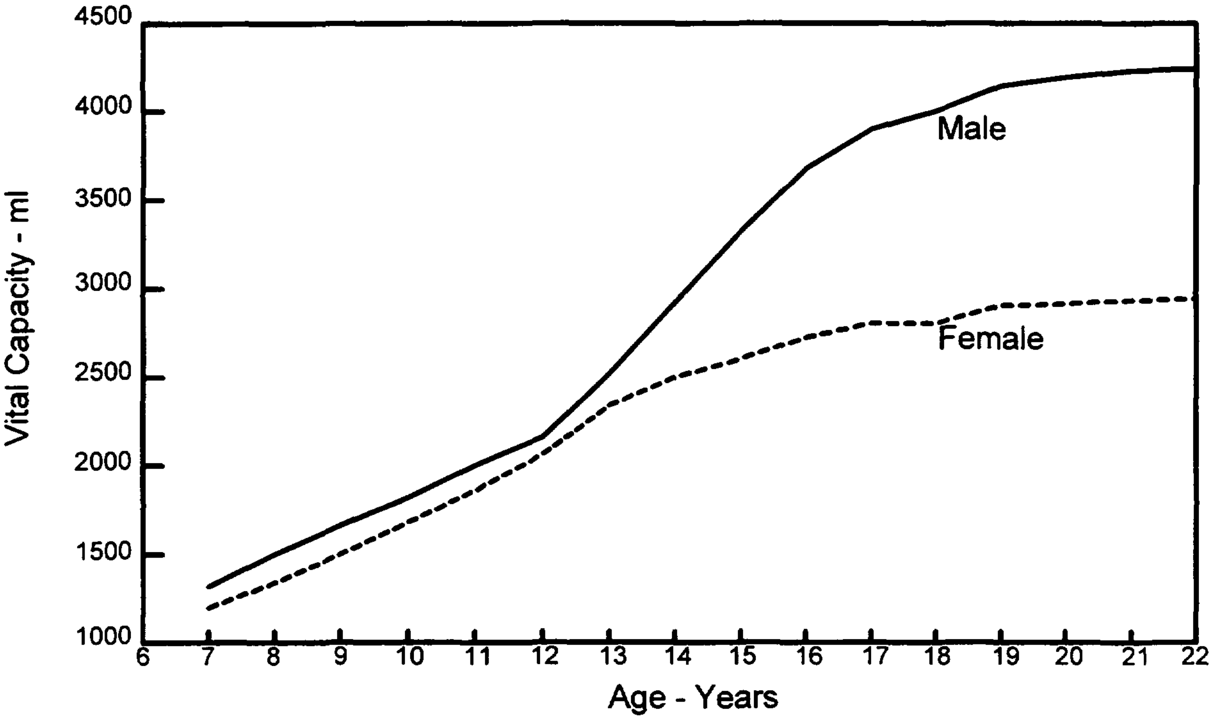

Fig. 5 - Vital capacity as a function of age

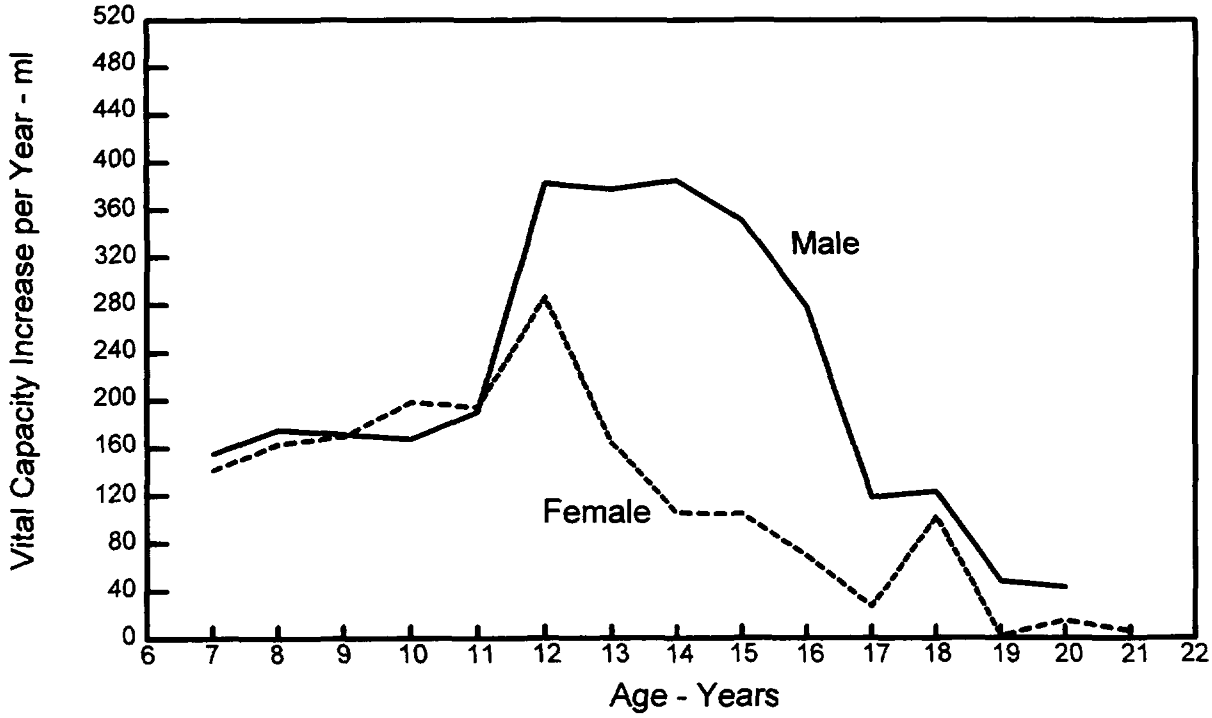

Fig. 6 - Increase in vital capacity as a function of age

TABLE XXIX. THE VALUES OF PULMONARY FUNCTION TEST OF DIFFERENT AGE AND SEX IN HEALTHY ADULTS

	15 - 19 (yrs)		20 - 29 (yrs)		30 - 39 (yrs)		40 - 49 (yrs)		50 - 59 (yrs)		> 60 (yrs)	
	M	F	M	F	M	F	M	F	M	F	M	F
VC	4 317 ± 0 539	3 018 ± 0 353	4 618 ± 0 640	3 252 ± 0 433	4 411 ± 0 519	3 311 ± 0 403	4 030 ± 0 603	3 002 ± 0 405	3 769 ± 0 508	2 689 ± 0 373	3 385 ± 0 487	2 399 ± 0 356
IC	2 648 ± 0 377	1 873 ± 0 262	2 774 ± 0 692	1 977 ± 0 333	2 767 ± 0 492	2 015 ± 0 418	3 593 ± 0 475	2 029 ± 0 540	2 424 ± 0 379	1 776 ± 0 218	2 292 ± 0 457	1 670 ± 0 241
ERV	1 669 ±0 300	1 183 ± 0 212	1 841 ± 0 340	1 275 ± 0 320	1 673 ± 0 327	1 313 ± 0 248	1 438 ± 0 885	1 024 ± 0 344	1 347 ± 0 446	0 908 ± 0 286	1 093 ± 0 385	0 709 ± 0 312
FRC	3 118 ± 0 497	2 348 ± 0 421	3 318 ± 0 562	2 358 ± 0 529	3 117 ± 0 491	2 501 ± 0 339	3 096 ± 0 814	2 217 ± 0 548	3 019 ± 0 610	0 294 ± 0 457	2 980 ± 0 644	2 329 ± 0 581
RV	1 411 ± 0 400	1 035 ± 0 325	1 581 ± 0 354	1 032 ± 0 379	1 559 ± 0 424	1 188 ± 0 301	1 641 ± 0 363	1 215 ± 0 240	1 725 ± 0 410	1 360 ± 0 294	1 770 ± 0 368	1 508 ± 0 331
TLC	5 796 ± 0 729	4 425 ± 0 608	6 096 ± 0 739	4 487 ± 0 637	5 993 ± 0 763	4 651 ± 0 623	5 662 ± 0 837	4 336 ± 0 628	5 583 ± 0 769	4 192 ± 0 562	5 465 ± 0 752	4 078 ± 0 726
RV/TLC	24 165 ± 4 714	23 615 ± 6 015	23 980 ± 5 336	25 230 ± 4 599	25 840 ± 5 584	24 520 ± 8 017	28 980 ± 4 459	28 670 ± 3 903	30 765 ± 4 988	32 350 ± 4 902	32 315 ± 4 481	37 010 ± 4 405
FVC	4 289 ± 0 508	3 116 ± 0 365	1 571 ±0 587	3 169 ± 0 409	4 319 ± 0 495	3 288 ± 0 548	3 868 ± 0 610	2 908 ± 0 444	3 600 ± 0 519	2 561 ± 0 373	3 219 ± 0 377	2 279 ± 0 355
FEV_1	3 752 ± 0 452	2 868 ± 0 372	3 824 ± 0 607	2 843 ± 0 418	3 577 ± 0 358	2 822 ± 0 458	3 157 ± 0 505	2 417 ± 0 330	2 855 ± 0 414	2 118 ± 0 261	3 559 ± 0 377	1 850 ± 0 292
FEV_1%	87 670 ± 6 153	91 965 ± 4 651	83 670 ± 8 639	89 710 ± 5 811	83 670 ± 6 036	86 185 ± 4 683	81 770 ± 3 740	83 700 ± 4 880	79 490 ± 6 177	43 110 ± 5 580	79 790 ± 3 971	80 840 ± 5 533

VC	Vital Capacity	TLC	Total Lung Capacity	$\dot{V}_1$	Ventilation Rest	$\dot{V}_{50}$	Expiratory Flow in 50% VC
IC	Inspiratory Capacity	FVC	Forced Vital Capacity	MBC	Maximum Breathing Capacity	$\dot{V}_{25}$	Expiratory Flow in 25% VC
ERV	Expiratory Reserve Volume	FEV_1	Forced Expiratory Volume in the First Second	BR	Breath Rate	D_1CO_{SB}	Single breath Diffusing Capacity of the Lung for Carbon Monoxide
FRC	Functional Residual Capacity	FEV_1%	$\frac{FEV_1}{FVC} \times 100\%$	PEF	Peak Expiratory Flow		
RV	Residual Volume	MMEF	Maximum Mid-expiratory Flow	$\dot{V}_{75}$	Expiratory Flow in 75% VC		

TABLE XXIX. THE VALUES OF PULMONARY FUNCTION TEST OF DIFFERENT AGE AND SEX IN HEALTHY ADULTS (CONTINUED)

	15 - 19 (yrs)		20 - 29 (yrs)		30 - 39 (yrs)		40 - 49 (yrs)		50 - 59 (yrs)		> 60 (yrs)	
	M	F	M	F	M	F	M	F	M	F	M	F
MMEF	4.556 ± 0.928	3.588 ± 0.675	4.387 ± 1.102	3.320 ± 0.910	3.546 ± 0.903	3.200 ± 0.730	3.170 ± 0.509	2.850 ± 0.820	2.867 ± 0.632	2.300 ± 0.850	2.358 ± 0.700	1.774 ± 0.638
V_E	6.185 ± 1.469	5.435 ± 1.152	6.854 ± 1.850	5.375 ± 1.479	6.845 ± 1.886	5.425 ± 1.514	6.285 ± 1.772	5.605 ± 1.110	6.625 ± 1.618	6.100 ± 2.005	6.980 ± 1.617	5.585 ± 1.437
MBC	135.180 ± 21.012	92.380 ± 12.469	134.700 ± 22.395	89.950 ± 12.882	131.765 ± 19.505	101.055 ± 21.557	112.670 ± 16.319	85.100 ± 16.358	103.425 ± 18.022	74.970 ± 9.360	87.525 ± 16.165	62.225 ± 10.946
BR	95.335 ± 1.826	94.060 ± 1.276	94.841 ± 1.405	93.580 ± 1.822	94.660 ± 1.839	94.500 ± 1.585	94.325 ± 1.777	93.155 ± 2.013	93.360 ± 2.249	91.840 ± 3.183	91.835 ± 2.217	90.840 ± 2.598
PEF	7.429 ± 0.967	5.398 ± 0.913	7.351 ± 1.404	5.573 ± 0.996	7.715 ± 1.429	9.190 ± 1.110	6.909 ± 1.166	5.797 ± 1.328	6.903 ± 1.297	4.938 ± 0.756	6.360 ± 1.577	4.682 ± 1.105
$\dot{V}_{75}$	6.234 ± 0.649	4.892 ± 0.717	5.975 ± 1.311	4.879 ± 0.893	6.156 ± 1.274	5.363 ± 0.984	5.823 ± 1.208	4.937 ± 1.945	5.539 ± 1.366	4.406 ± 0.869	5.414 ± 1.690	4.053 ± 0.891
$\dot{V}_{50}$	4.201 ± 0.953	3.510 ± 0.642	6.862 ± 1.103	3.216 ± 0.706	3.590 ± 0.946	2.211 ± 0.815	3.360 ± 0.784	2.989 ± 0.901	2.936 ± 0.985	2.653 ± 0.957	2.623 ± 0.772	2.146 ± 0.626
$\dot{V}_{25}$	1.950 ± 0.478	1.911 ± 0.841	1.982 ± 0.699	1.585 ± 0.425	1.419 ± 0.481	1.154 ± 0.525	1.038 ± 0.308	0.943 ± 0.360	0.915 ± 0.414	0.752 ± 0.358	0.697 ± 0.293	0.467 ± 0.159
$\dot{V}_{50}/\dot{V}_{25}$	2.131 ± 0.300	2.084 ± 0.506	8.091 ± 0.439	2.081 ± 0.350	2.618 ± 0.611	3.817 ± 0.587	3.436 ± 1.311	3.252 ± 0.674	3.364 ± 0.857	3.556 ± 1.1110	3.913 ± 1.054	4.954 ± 1.840
D_LCO_{SB}	30.350 ± 5.150	10.890 ± 2.536	29.810 ± 3.244	20.000 ± 3.167	27.870 ± 3.934	20.060 ± 2.140	23.735 ± 4.317	18.163 ± 3.976	21.525 ± 3.598	15.600 ± 2.590	17.925 ± 3.410	13.120 ± 1.897

V. ANALYSIS ELEMENTAL CONTENT IN ORGANS OF NORMAL CHINESE

Fifty-three adult accidental death victims were examined within 24 hours after death from 1989 to 1991. Seventeen organs (stomach, large intestine, small intestine, heart, liver, spleen, lung, kidney, skeleton, cerebrum, thymus, pancreas, adrenal gland, thyroid, pituitary, testes and ovaries) of each victim were weighted and sampled for analysis of content of 15 elements (Zn, Cu, Mn, Fe, Cd, K, Na, Ca, Mg, Cr, Ni, Co, Mo, Sr, and Pb). The chemical analysis to determine the concentration of elements in the organs were carried out using an atomic absorption spectrophotometer. The results of analysis are presented in Table 26 (1-3) and compared with the corresponding values for ICRP Reference Man (Table 27).

For most of elements, the values are close to those reported for ICRP Reference Man. For a few elements such as Zn in thyroid, Pb in bone, and Cd in kidney, the contents are lower than those for ICRP. However, the concentration of Ni in heart, Zn in adrenal and thymus, Mn and Mo in rib and Cr in all tissues are all higher than those for ICRP Reference Man, as shown in Table 2.

In general, the elemental concentration in various organs and tissues of normal Chinese are roughly the same as those for Japanese or Indian. However, there are individual differences in the concentration of specific elements. For example, the average Cu concentration in adrenal gland and Pb in kidney for Chinese are markedly lower than those for Indian. The concentrations of Ca in heart, liver, spleen, kidney, cerebrum and pancreas of Chinese are several times lower than those for Japanese. The average Sr concentration in these tissues are higher than those for Japanese. The average Cd concentration in liver and kidney are also lower than those for Japanese.

TABLE XXX. THE CORRELATION COEFFICIENT OF AGE, HEIGHT AND WEIGHT WITH PULMONARY FUNCTION IN HEALTHY ADULTS

Items	Age (yrs)		Height (cm)		Weight (kg)	
	M	F	M	F	M	F
VC	- 0.579	- 0.576	0.670	0.570	0.304	0.239
IC	- 0.327	- 0.243	0.539	0.318	0.566	0.375
ERV	- 0.534	- 0.562	0.372	0.521	- 0.202	- 0.094*
FRC	- 0.118*	- 0.099*	0.461	0.346	- 0.158	- 0.108*
RV	0.295	0.456	0.308	0.037*	- 0.072*	0.021*
TLC	- 0.236	- 0.253	0.683	0.394	0.170	0.117*
RV/TLC	0.526	0.695	- 0.099*	- 0.232	- 0.199	- 0.029*
FVC	- 0.653	- 0.625	0.655	0.524	0.240	0.216
FEV_1	- 0.729	- 0.752	0.576	0.522	0.135*	0.091*
FEV_1%	- 0.415	- 0.595	0.029*	0.152*	- 0.159	- 0.226
MMEF	- 0.714	- 0.669	0.210	0.323	- 0.211	- 0.004*
$\dot{V}_E$	0.061*	0.060*	0.147*	0.017*	0.227	0.205
MBC	- 0.650	- 0.505	0.377	0.326	0.041*	0.179
BR	- 0.528	- 0.493	0.147*	0.316	-0.087	-0.0413
PEF	- 0.295	- 0.323	0.226	0.333	0.263	0.236
$\dot{V}_{75}$	- 0.249	- 0.355	0.210	0.354	0.172	0.193
$\dot{V}_{50}$	- 0.522	- 0.500	0.215	0.208	-0.123	- 0.002*
$\dot{V}_{25}$	- 0.733	- 0.712	0.272	0.322	-0.233	- 0.082*
$\dot{V}_{50}/\dot{V}_{25}$	0.638	0.745	- 0.211	-0.367	0.246	0.070*
D_LCO_{SB}	- 0.771	- 0.687	0.425	0.466	0.008*	0.197

* P > 0.051, Rest P < 0.05

TABLE XXXI. THE NORMAL PREDICTIVE EQUATION OF 9 INDEXES IN PULMONARY FUNCTION

Items	Sex	Normal predictive equation	r
VC	M	- 5.425 - 0.020 x A + 0.058 x H + 0.012 x W	0.8118
	F	- 2.827 - 0.012 x A + 0.04 x H	0.7359
FRC	M	- 7.812 + 0.005 x A + 0.079 x H - 0.042 x W	0.6473
	F	- 4.955 + 0.005 x A + 0.055 x H - 0.030 x W	0.5564
RV/TLC	M	- 2.31 + 0.218 x A + 0.232 x H - 0.295 x W	0.6289
	F	22.091 + 0.284 x A - 0.091 x W	0.7014
MMEF	M	1.50 - 0.046 x A + 0.032 x H - 0.028 x W	0.7342
	F	4.339 - 0.038 x A	0.6689
MBC	M	- 38.20 - 0.987 x A + 1.162 x H	0.6986
	F	76.193 - 0.633 x A + 0.636 x W	0.5548
$\dot{V}_{75}$	M	4.69 - 0.022 x A + 0.035 x W	0.3271
	F	- 2.889 - 0.016 x A + 0.053 x H	0.4891
$\dot{V}_{50}$	M	4.75 - 0.033 x A	0.5222
	F	4.003 - 0.026 x A	0.4996
$\dot{V}_{25}$	M	- 1.35 - 0.025 x A + 0.030 x H - 0.022 x W	0.7743
	F	2.318 - 0.029 x A	0.7120
D_LCO_{SB}	M	- 10.30 - 0.254 x A + 0.273 x H	0.8146
	F	- 4.303 - 0.136 x A + 0.151 x H + 0.079 x W	0.7788

A = Age (yrs), H = Height (cm), W = Weight (kg), M = Male, F = Female

On the other hand, the differences by sex for concentration of some elements in organs are found. For example, in male adult, the concentration of Fe in liver, spleen and lung, Ni in thymus are all higher than those for female in normal Chinese (as shown in Figs 3 and 4).

VI. PULMONARY FUNCTION OF NORMAL CHINESE

There are a few data on complete indexes of pulmonary function, but a lot of data are available on vital capacity measurements for Chinese students from 7 to 22 years old [6.8]. Figs 5 and 6 show the increasing vital capacity of students with age. The vital capacity of both male and female students increased with age from 7 - 22. The average increase per year was 194.2 ml for male and 116.4 ml for female. The period of maximum increase in vital capacity for male was 12-15 years old and 10-12 for female. After 21 years old for male and 19 for female the vital capacity becomes stable. The mean vital capacity of female was 70% of that of male.

Systematic tests of pulmonary function (including 20 indexes) were conducted in healthy adults in 1986 to establish reference values based on the reference value of height and weight of total body for various age and sex groups. The results are presented in Tables 28 and 29. Taking the age, height and weight of total body as the independent variables, the best regression equations and the multiple correlation regression coefficients for each index were

TABLE XXXII. CALCULATED REFERENCE VALUES OF 9 INDICES OF PULMONARY FUNCTION FOR VARIOUS AGE AND SEX GROUPS

Age	Sex	VC	FRC	RV/TLC	MMEF	MBC	$\dot{V}_{75}$	$\dot{V}_{50}$	$\dot{V}_{25}$	D_LCO_{SB}
15 - 19	M	4.527	3.193	24.132	4.666	139.887	6.180	4.255	2.111	31.208
Years	F	3.273	2.315	21.983	3.769	97.226	5.192	3.613	1.883	21.156
20 - 30	M	4.655	3.223	24.880	4.110	134.665	6.240	3.925	1.805	29.760
Years	F	3.273	2.410	24.459	3.389	93.440	5.191	3.353	1.593	20.565
20 - 50	M	4.397	3.194	26.828	3.618	123.633	6.020	3.595	1.525	26.947
Years	F	3.073	2.350	27.299	3.009	87.110	4.925	3.093	1.303	18.903

Note:

VC: Vital Capacity
FRC: Functional residual volume
RV/TLC: Residual Volume/total lung capacity
MMEF: Maximum mid-expiratory flow
MBC: Maximum breathing capacity
$\dot{V}_{75}$ Expiratory flow in 75% vital capacity
$\dot{V}_{50}$: Expiratory flow in 50% vital capacity
$\dot{V}_{25}$: Expiratory flow in 25% vital capacity
D_LCO_{SB}: Single-breath diffusing capacity of the lung for carbon monoxide

TABLE XXXIII. ELEMENTAL CONTENT OF ORGANS AND TISSUES OF REFERENCE MAN IN ICRP-23 PUBLICATION

Organ and tissue	Element (µg/g wet sample)														
	Zn	Cu	Mn	Fe	Cr	Ni	Co	Mo	Sr	K	Na	Ca	Mg	Pb	Cd
Stomach	18 67	1 67	0 306	28 67	0 014	0 041	0 016	0 031	0 080	1400	1000	66 67	106 67	0 093	0 400
Large intestine	19 46	1 30	0 594	20 00	0 027	0 110	0 008	0 027	0 197	1108	1000	113 0	148 65	0 124	0 350
Small intestine	18 75	1 56	0 546	26 56	0 020	0 055	0 017	0 050	0 144	1359	1000	84 34	120 31	0 131	0 420
Heart	25 45	3 33	0 200	45 45	0 016	0 048	0 030	0 039	0 025	2182	1212	36 36	163 64	0 055	0 480
Liver	47 22	6 67	1 388	177 8	0 009	0 067	0 061	1 800	0 018	2500	1000	50 00	172 20	1 700	2 220
Spleen	17 77	1 22	0 128	272 2	0 072	0 072	0 035	0 060	0 288	3111	1222	66 66	127 66	0 350	0 722
Lung	11 00	1 20	0 120	36 00	0 090	0 047	0 002	0 031	0 057	1900	1800	87 00	71 00	0 390	0 350
Kidneys	48 39	2 90	0 903	74 19	0 010	0 055	0 013	0 035	0 058	1903	2000	93 55	129 03	1 097	31 900
Skeleton*	48 00	0 72	0 520	81 00	0 480	0 500	0 028	0 040	32 00	1500	3200	100000	1100 0	11 00	1 20
Cerebrum	12 14	5 79	0 278	52 86	0 003	0 079	0 032	0 064	0 024	3000	1571	85 71	150 00	0 100	0 785
Thymus	6 50	0 70	0 090	11 0	0 009	0 022	0 009	0 011	0 070	600	-	85 00	30 00	0 050	0 700
Pancreas	25 00	1 50	1 100	39 00	0 018	0 060	0 024	0 048	0 035	2300	1400	91 00	160 00	0 550	0 960
Adrenal gland	7 86	1 07	0 717	37 14	0 050	0 036	0 014	0 069	0 016	1000	-	40 71	44 29	0 121	0 350
Thyroid	31 00	1 10	0 200	55 00	0 014	0 060	0 011	0 045	0 130	1200	2200	350 0	100 00	0 200	0 700
Testes	14 86	0 83	0 128	23 43	0 037	0 054	0 022	0 043	0 046	2000	1000	113 0	148 65	0 128	0 540

* Rib

derived by using the method of step wise regression. The correlation coefficients of age, height and weight with pulmonary function parameter in healthy adult are listed in Table 30 and the normal predictive equations of 9 indexes in pulmonary function test are shown in Table 31. The reference values for the 9 indices, calculated based on the normal predictive equations, are listed in Table 32.

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STUDIES OF THE ANATOMICAL, PHYSIOLOGICAL AND METABOLIC CHARACTERISTICS OF THE INDIAN POPULATION FOR SETTING UP A REFERENCE MAN

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Abstract

This paper presents Indian data on various human characteristics such as physical, anatomical, physiological and metabolic parameters. The knowledge of these parameters is required for dosimetric purposes and for developing secondary radiation standards for occupational workers and the general public. The data reported are for the adult population, as well as for the younger population at the ages newborn, and 1, 5, 10 and 15 years. On the basis of the collection, collation and generation of the above data, the characteristics of the Reference Indian Man are proposed. The comparison of Indian data with that for ICRP Reference Man (representing the Caucasian population) shows that most of the physical, physiological and anatomical characteristics of the Indian population are smaller. The weights of a few smaller organs such as thyroid, testes, etc. are comparable and the daily intake of drinking water, the sweat rate and urine excretion rate etc. are higher than those for ICRP Reference man.

INTRODUCTION

The description of human data on physical, physiological, anatomical and metabolic parameters is required for radiation control and assessment (internal and external dosimetry): 1) through the development of appropriate phantom for calibration purposes, 2) by recommending realistic secondary radiation standards such as ALI (annual limit on intake), DAC (derived air concentrations) for various radionuclides, and 3) by obtaining the reliable metabolic factors (retention half-lives, distribution factors-F2) for different radionuclides.

Until recently, the radiation protection practices in different countries made use of the reference data compiled by the International Commission on Radiological Protection (ICRP) [1]. These data however are representative of the caucasian population (European and North American in origin). A few of the studies carried out in India [2-5] and in Japan [6], have demonstrated beyond doubt that Asians are much different from Caucasians in physique, as well as in customs and habits. This realization underlines the need to develop the human models representative of Indian and Asian population in order to strengthen the radiation protection in this region.

After the Chernobyl Nuclear Accident in Russia (1986) it became clear that it is not only the radiation worker (adult population group), but also the members of the public in other age groups (including younger age groups) who are also exposed to the risk of radiation. It, therefore, became necessary to obtain additional data on the relevant parameters for newborn, and 1, 5, 10, and 15 year age groups.

In Bhabha Atomic Research Centre, a programme was undertaken to collect, collate and generate relevant reference data for radiation protection purposes. This report deals with the data for Indian population on different parameters: 1) physical and anthropometric, 2) anatomical, 3) physiological, and 4) metabolic parameters. Wherever possible, data on the younger age groups are also reported.

PHYSICAL AND ANTHROPOMETRIC DATA

Body Weight and Height

The weight and height on the Indian population in different age groups are shown in Table 1. The main source of these data are three extensive reports [7-9] for surveys carried out for rural and urban populations, by the National Nutrition Monitoring Board (NNMB) in India. The data on weight of newborns were collected by Dang et al [10]. The data on newborns is also supported by the body weight data reported by many other workers [11-16]. The extensive studies carried out by NNMB [7-9] assume greater importance in view of the fact that weight and height parameters, even for the same age groups, have been shown to vary with different factors such as, the origin of the population group (rural or urban), socio-economic status, religion, etc. [17].

The data reported in Table 1 are the weighted means of the different socio-economic groups in the urban and rural areas. Additional weight was given to the distribution of population in the urban (27%) and rural population (73%) to arrive at the final data. The repeat survey (NNMB Report 1988-90) [9] of the rural population group, after 10-12y period, showed an increase of about 1 Kg body weight in male adults. A marginal increase was also observed in the height. For the female population however, this effect was less pronounced.

TABLE I. WEIGHT AND HEIGHT OF INDIAN POPULATION (MALE AND FEMALE) IN DIFFERENT AGE GROUPS

Age group (year)	Weight (Kg)		Height (cm)	
	Male Mean±SD	Female Mean±SD	Male Mean±SD	Female Mean±SD
Newborn*	2.9±0.3 (250)	2.8±0.3 (250)	49.0±2.0 (250)	48.0±2.0 (250)
0.25	6.2±1.6 (2,284)	5.9±1.0 (2,088)	63.6±6.0 (2,284)	62.7±7.0 (2,088)
1	8.5±1.5 (1,643)	8.1±1.5 (1,357)	74.4±5.0 (1,643)	72.4±5.5 (1,357)
5	14.6±2.0 (1,477)	14.2±2.0 (1,360)	102.7±6.0 (1,477)	100.8±9.0 (1,360)
10	22.9±3.5 (1,454)	22.9±3.4 (1,302)	128.1±7.0 (1,454)	128.5±7.0 (1,302)
15	38.3±6.5 (954)	38.7±6.0 (764)	154.2±8.5 (954)	148.8±6.0 (764)
20	48.6±6.1 (2,461)	43.3±5.5 (3,800)	163.3±7.0 (2,461)	151.0±6.0 (3,800)
20-50	51.5±8.5 (12,189)	44.2±8.0 (14,101)	163.4±7.5 (12,189)	151.0±6.5 (14,101)

* Newborn includes ages up to one week

The number of subjects covered in each population group are shown in parenthesis.

TABLE II. SITTING HEIGHT AND CHEST CIRCUMFERENCE OF THE INDIAN POPULATION (MALE AND FEMALE) IN DIFFERENT AGE GROUPS

Age group (year)	Sitting height (cm)		Chest circumference (cm)	
	Male Mean±SD	Female Mean±SD	Male Mean±SD	Female Mean±SD
Newborn*	33.0±3.5 (240)	32.5±2.8 (260)	35.0±2.5 (240)	34.1±3.8 (250)
1	45.4±2.9 (2,906)	44.2±2.9 (2,906)	43.3±4.7 (2,874)	42.3±4.0 (2,654)
5	57.0±3.3 (3,484)	56.0±3.4 (3,484)	50.8±5.4 (2,358)	50.1±3.8 (2,175)
10	67.5±3.6 (4,065)	67.1±4.0 (4,065)	59.1±4.8 (2,809)	58.4±4.7 (2,523)
15	79.8±5.2 (3,609)	77.9±3.7 (3,609)	70.9±7.6 (2,122)	71.5±6.5 (1,394)
20	85.0±3.6 (1,757)	79.2±3.5 (1,757)	77.3±8.6 (1,140)	74.6±6.3 (552)
20-50	85.8±4.7 (270)	80.0±4.1 (250)	80.8±8.7 (270)	78.0±6.0 (260)

* Newborn includes ages up to one week

The number of subjects covered in each population group are shown in parenthesis.

Sitting Height, Chest Circumference, Head Circumference and Head Diameter

The source of data for these two parameters for population in the 1, 5, 10, 15 and 20 year age groups is the national level survey conducted (1956-65) by the Indian Council of Medical Research (ICMR) [17]. The data in the newborn and 20-50y age groups were collected by the authors. The figures given in parenthesis denote the number of subjects included for the study of each parameter. It should be noted that in the extensive study by ICMR, due consideration was given to different variables by carefully choosing the subjects included in the study.

The data collected by the authors is for a smaller number of subjects, but is equally important, because the subjects studied by the authors were from the target population (low to lower middle income group with body weight and height dimensions within one to two standard deviations of the mean for these age groups).

Proposed Physical Data for Reference Indian Man

The measured data on adult population along with the proposed reference values are shown in Table 4. The dimensions of some of the physical parameters such as, body height, weight, body surface area and sitting height have been rounded to the nearest integer. This

TABLE III. HEAD CIRCUMFERENCE AND DIAMETER FOR INDIAN POPULATION (MALE AND FEMALE) IN DIFFERENT AGE GROUPS

Age group (year)	Head circumference (cm)		Head diameter (cm)	
	Male Mean±SD	Female Mean±SD	Male Mean±SD	Female Mean±SD
Newborn*	38.0±3.9 (250)	37.0±3.4 (240)	9.1±0.3 (18)	9.0±0.2 (10)
0.25	41.6±2.9 (424)	40.6±3.6 (293)	---	---
1	44.4±3.6 (2,903)	43.6±1.8 (2,643)	---	---
5	48.5±2.7 (2,241)	47.8±1.7 (2,159)	13.0±1.1 (240)	13.2±1.6 (210)
10	50.4±1.7 (2,647)	50.1±1.6 (2,784)	13.4±1.2 (230)	13.6±1.4 (215)
15	52.6±1.8 (2,337)	52.2±1.8 (1,627)	14.8±1.0 (200)	14.2±1.5 (190)
20	53.6±1.7 (939)	52.6±1.7 (421)	15.0±1.3 (180)	14.3±1.3 (160)
20-50	54.0±2.0 (210)	52.9±2.1 (250)	15.1±1.3 (290)	14.3±1.2 (220)

* Newborn includes ages up to one week

The number of subjects covered in each population group are shown in parenthesis.

was done on the basis of the observed increase in the physical dimensions of adult population in the revised survey conducted by NNMB [9] after a gap of about 10y. The reference data being obtained now, is likely to be used in years to come. So the rounding off of the dimensions to the higher side (by about 2-3%) for the proposed Reference Indian Man would be appropriate. The body surface area was based on the reported values (Vyas, et al, 1965; Banerjee and Sen, 1958; Kamat, et al, 1977) as well as by applying the Du Bois (1916) [20] formula to the weight and height data obtained for the adult population.

ANATOMICAL

Anatomical data such as the weights and sizes of the body organs along with other physical features are required for the development of a realistic phantom as well as for internal dosimetry. Until now, the dimensions and weights of body organs for caucasian population (MIRD phantom) [49] were being used for dose calculations.

The radiation dose is generally assessed in terms of the energy deposited per unit mass of the organ. Venkatraman, et al (1963) [22] reported lower organ weights for the adult Indian population and suggested that for the Indian adult, the radiation dose per unit intake of

TABLE IV. MEASURED AND PROPOSED PHYSICAL DATA ON ADULT INDIAN (MALE AND FEMALE) POPULATION

Parameter	Male		Female	
	Measured	Proposed	Measured	Proposed
Body Wt. (kg)	51.5±8.5	52.5	44.2±8.0	45.
Standing Ht. (cm)	163.4±7.5	164	151.0±6.5	151.
Sitting Ht. (cm)	85.8±4.7	86	80.0±4.1	80.
Body surface area (M^2)	1.61±0.16	1.62	1.40±0.06	1.40
Chest width (cm)	38.0±3.1	38.	37.0±4.0	37.
Chest Circum. (cm)	80.8±8.7	81.	78.0±6.0	78.
Chest depth (cm)	19.0±2.0	19.	18.0±2.0	18.
Head Circum. (cm)	54.0±2.0	54.	53.0±2.0	53.
Head Dia. (cm)	15.0±1.0	15.	14.0±1.0	14.
Head depth (cm)	19.0±2.0	19.	18.0±2.0	18.
Head Ht. (cm)	23.0±2.0	23.	21.0±2.0	21.
Neck Circum. (cm)	35.0±5.0	35.	31.0±4.0	31.

radioactivity would be larger in comparison to that for the caucasian population. On the basis of this observation they had suggested to lower the maximum permissible body burden (MPBB) levels for a large number of radionuclides.

The studies of Venkatraman, et al [22] provided information on the weighted mean organ weights on the combined male and female population which was reported as Indian Standard Man data at that time. A more detailed study was therefore needed to obtain data on individual male and female populations in adult and also on the younger age groups.

The data collected earlier was critically evaluated and additional data were collected to obtain the organ weights for the adult and younger population. These data were obtained from 24 medical institutions located in 18 cities of India covering almost the entire region of the country (Fig. 1). In all, about 14,500 post mortem cases (about 10,000 male and 4,500 female) of accidental deaths were studied. These subjects were healthy at the time of the accident.

In the case of the population in younger age groups, because of the practical difficulties and other considerations, only a smaller number of subjects (10-50 in each age group) could be studied to obtain the organ weight data.

Organ Weights for Different Age Groups

The mean organ weights along with the associated standard deviations (SD) for brain, heart, kidneys (2), liver, lungs (2), spleen, pancreas, testes (2) and thyroid, for 0, 1, 5, 10, 15y, and adult age groups are shown in Tables 5 and 6. The figures given in parenthesis are for the number of subjects studied for each organ and in each age group. In the case of lungs, kidneys, testes, the weight of both right and left organs were added to obtain the final weight.

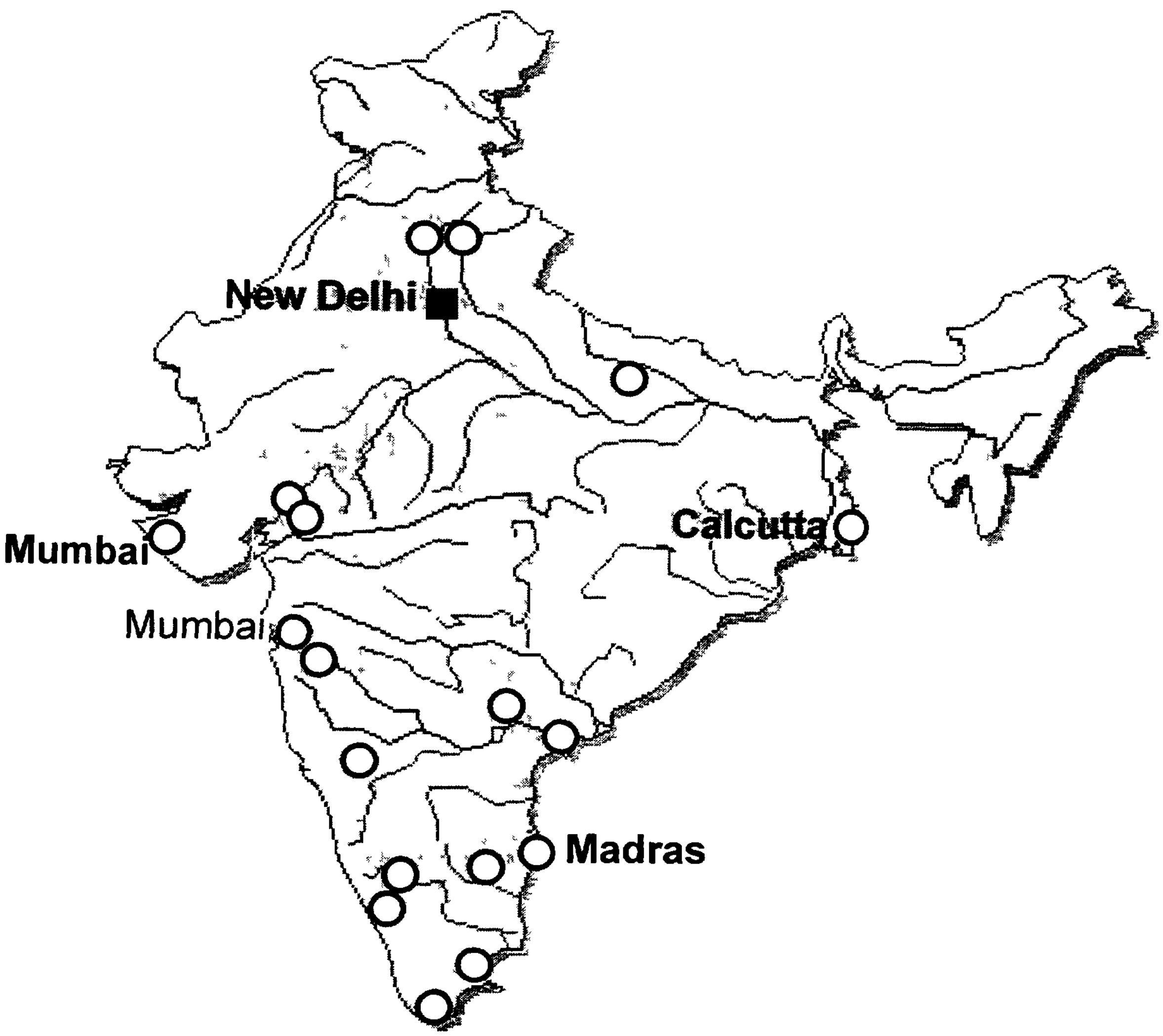

FIG 1. Indian sampling locations for anatomical studies

The organ weight data for the newborns of both male and female sex were combined to obtain the final data because: 1) the number of subjects belonging to either sex were rather small, and 2) the differences between the individual organ weights at the newborn stage were not statistically significant.

The average weights of only those organs are reported in Tables 5 and 6, for which the data could be obtained from at least four different locations in the country. The limited data on the organ weights of the younger age group also covers one location each from north, west, south and east India.

Proposed Organ Weights for Reference Indian Man

The data obtained on the organ weights of the adult Indian population are extensive and large enough to use as the basis to propose anatomical parameters for RIM. Table 7 gives the values of the proposed organ weights for the adult population along with the measured data. The proposed weights are marginally higher for the major organs, because it was observed that the weights of the larger organs are in proportion to the body weight and the body weight of the Indian adult has shown increase at the rate of 1 kg in every ten years (NNMB Report 1988-90) [9]. Therefore the weights have been rounded off on the higher side by increasing their values by about 2-3% of the observed values.

TABLE V. MEAN (± sd) ORGAN WEIGHTS OF INDIAN POPULATION IN DIFFERENT AGE GROUPS - (g)

Organ	Age - years				
	Newborn	1		5	
	Combined	M	F	M	F
Brain	295±138 (15)	785±133 (10)	670±215 (12)	986±230 (14)	1010±230 (10)
Heart	17±7 (14)	39±12 (13)	35±12 (10)	73±50 (23)	74±28 (14)
Kidney (2)	20±7 (14)	56±16 (13)	51±18 (10)	98±39 (26)	95±39 (11)
Liver	99±32 (14)	250±103 (12)	222±81 (10)	478±172 (25)	448±150 (16)
Lungs (2)	63±21 (11)	123±36 (12)	98±30 (12)	252±137 (25)	208±55 (18)
Spleen	7±4 (14)	23±13 (12)	21±8 (10)	58±31 (24)	58±23 (14)
Pancreas	3±1 (10)	14±6 (16)	11±6(10)	25±12 (16)	31±13 (12)
Testes (2)	2±1 (11)	3±1 (10)	--	6±3 (11)	--
Thyroid	1.5±0.4 (18)	3±1 (10)	--	4±2 (13)	--

The number of subjects covered in each population group are shown in parenthesis.

PHYSIOLOGICAL PARAMETERS

The data on the physiological parameters such as pulmonary function, water balance and body composition for adult Indian population only are reported. It was not possible to obtain the physiological data for the younger age groups.

Pulmonary Function

The knowledge of the pulmonary standards is important in radiation protection. Some of these parameters have been reported to determine the retention pattern of the inhaled airborne aerosols in the pulmonary region of the human body (Subaramu, 1974; Bell and Gilland, 1964; Bouhuys, 1970) [23-25]. The pulmonary standards included in the present study are: vital capacity, maximum breathing capacity, minute volume, respiratory rate and tidal volume.

The vital capacity obtained for 2,620 male subjects (age range 17-54y) by 18 different workers from different regions of India [5, 23, 28-41] were in the range 2.8-4.0 L with a mean value of 3.3 ± 0.4 L. The highest value of vital capacity was for the north Indian population which is also reported [17] to have larger physical parameters in comparison to those for the average Indian. For female subjects, there are only two studies. The systematic study carried out by Kamat, et al [5] for about 500 female subjects in the age range 18-47y, gave the mean vital capacity figure of 2.2 ± 0.2 L. The average vital capacity reported for females by the other worker is also similar to that reported by Kamat, et al. The results are shown in Table 8. In comparison to the ICRP data [1], Indian values are 30% lower. One or two of the isolated studies on the population groups whose body weight and height were not representative of the average Indian have not been included [55].

Maximum breathing capacity data are reported for 940 male subjects (age range 17-62y) by 8 workers [8, 34-40] and data for female subjects is reported for 572 subjects [5,37]. On the basis of the results, mean maximum breathing capacity values of 123 ± 15 L and 78 L were obtained for male and female subjects respectively (Table 8). There are no equivalent data available for ICRP Reference Man to compare with.

TABLE VI. MEAN (± sd) ORGAN WEIGHTS OF INDIAN POPULATION IN DIFFERENT AGE GROUPS - (g)

Organ	Age - years					
	10		15		Adult (>18 Years)	
	M	F	M	F	M	F
Brain	1142±182(15)	1084±182 (14)	1208±172 (23)	1150±100 (18)	1236±127 (9,599)	1140±120 (3,070)
Heart	140±58 (30)	134±78 (21)	208±95 (35)	220±105 (29)	243±52 (9,599)	211±47 (3,194)
Kidney (2)	141±37 (27)	143±32 (20)	198±51 (38)	217±54 (31)	224±48 (9,599)	207±47 (3,194)
Liver	785±203 (30)	617±208 (21)	888±245 (36)	954±244 (31)	1135±251 (9,501)	1051±226 (3,190)
Lungs (2)	462±220 (29)	413±198 (20)	645±242 (41)	598±226 (29)	841±154 (6,887)	670±140 (2,307)
Spleen	102±55 (25)	89±62 19)	118±49 (35)	132±44 (28)	137±67 (9,626)	119±59 (3,194)
Pancreas	55±15 (17)	47±15 (11)	80±28 (20)	73±25 (14)	96±34 (714)	82±32 (298)
Stomach	--	--	--	--	135±25 (2,680)	140±34 (796)
Testes (2)	7±2 (11)	--	22±15 (10)	--	35±5 (350)	--
Thyroid	8±3 (10)	--	12±5 (11)	--	19±7 (500)	18±7 (120)

The number of subjects covered in each population group are shown in parenthesis.

TABLE VII. THE MEASURED AND PROPOSED ORGAN WEIGHTS FOR REFERENCE INDIAN MAN (RIM) - (g)

Organ	Weight (g)			
	Male		Female	
	Measured	Proposed	Measured	Proposed
Brain	1236	1250	1140	1150
Heart	243	250	211	220
Kidney (2)	224	230	207	210
Liver	1135	1175	1050	1075
Lungs (2)	841	870	670	690
Spleen	137	140	119	120
Pancreas	96	100	82	85
Stomach	135	135	125	125
Prostate	21	20	--	--
Testes (2)	35	35	--	--
Adrenals	13	13	12	12
Thyroid	19	19	18	18

Tidal volume is the amount of air or gas breathed in and out in one cycle. Four studies for the male subjects [5,23,38,41] and two for the female subjects [6,36] are reported in the literature. The tidal volume for Indian subjects was in the range 0.51 - 0.61 L and 0.35 - 0.42 L respectively.

Respiratory rate is the number of cycles in one minute that the air is breathed in and out by an individual. The three studies reported in the literature [5,23,41] for both male and female subjects give mean values of 19.7 and 20 for male and female population respectively. The authors however in the present study obtained a lower value of 15 cycles each for both male and female populations. About 80 cases each were studied for the two population groups. The respiratory rate reported by ICRP Reference Man [1] is also 15 for both male and female population groups.

Minute volume is the volume of air breathed in and out in one minute, and is obtained by multiplying tidal volume and the respiratory rate. If the RR values reported by other workers [5,23,41] is used to obtain the minute volume for the Indian population, then higher minute volume is obtained in comparison to the ICRP value [1] (Tables 8 and 9). However when the RR value of 15 obtained by the authors is employed, then the value thus obtained for the Indian population is comparable with ICRP data. The authors propose to use the later value.

There is only one study that presents data on total lung capacity [5]. Data were obtained for 55 male and 27 female subjects from South India in the age range 20-50y. The mean total lung capacity reported is 4.9 ± 0.2 L and 3.7 ± 0.2 L respectively for the male and female group. The total lung capacity reported for ICRP Male is 4.4 L.

TABLE VIII. PULMONARY STANDARDS FOR ADULT INDIAN POPULATION

Parameter	No. of Studies	Age group (years)	No. of subjects	Measured range	Values (L) Mean ± SD
Vital Capacity (VC)					
Male	18	17 - 54	2,620	2.80 - 3.98	3.3 ± 0.4
Female	1	18 - 47	504	--	2.2 ± 0.2
Maximum Breathing Capacity (MBC)					
Male	8	17 - 62	940	110 - 153.6	125.3 ± 18
Female	2	17 - 47	572	--	78.0
Tidal Volume (TV)					
Male	4	adult	--	0.51 - 0.65	0.54 ± 0.08
Female	3	adult	--	0.35 - 0.42	0.38 ± 0.03
Respiratory Rate (RR)					
Male	3	adult	--	19 - 21	19.7 ± 1.0
Female	3	adult	--	19.4 - 21	20.0 ± 1.0
Minute Volume (MV)					
Male		TV x RR = 19.7 x 0.54 (15x0.54)			10.6 (8.1)
Female		TV x RR = 20 x 0.38 (15x0.38)			7.6 (5.7)

TABLE IX. PULMONARY STANDARDS FOR INDIAN ADULT POPULATION AND ICRP REFERENCE MAN

Parameter	Values in liters			
	Indian		ICRP	
	Male	Female	Male	Female
Vital capacity (VC)	3.3	2.2	4.3	3.3
Maximum breathing capacity (MBC)	125.3	78	--	--
Tidal volume (TV)	0.54	0.38	0.5	0.4
Respiratory rate (RR)	15.0	15.0	15	15
Minute volume (MV)	8.1	5.7	7.5	6.0

TABLE X. BODY COMPOSITION FOR ADULT INDIAN POPULATION GROUPS

	Parameter	Measured value (l)	Average body wt. of population (kg)	ml per kg body wt. (ml/kg)	Ref.
A)	Blood Volume (l)				
	1	4.00	52.5 (M&F)	76.2	[19]
	2 A	3.61	50.0 (M)	72.2	[18]
	2 B	4.60	62.5 (M)	73.6	"
	2 C	3.20	43.5 (F)	73.5	"
	Average			73.9	
B)	Total body water (l)			Percentage of body weight	
	1	31.7±0.8	52.5 (M&F)	62.1	[19]
	2	34.5±5.2	59.0 (M)	58.6	[42]
	Average			60.3	
C)	Extra cellular fluid	11.6±0.3			
	Intra cellular fluid	20.1±0.5			
D)	Lean Body Mass			Percentage of body weight	
	Lean body mass (LMB)	44.8	52.5 (M&F)	87.7	[19]
	(Kg)		59 (M)	79.8	[42]
	Lean body mass	47.1			
E)	Total body fat (kg)	6.8±1.1	52.5 (M&F)	13.0	[19]
F)	Skeleton weight (kg)	6.5	50 (M)		[43]
G)	Mineral (kg)	3.1±0.1	52.5 (M&F)	6.1	[19]

Body Composition

The data reported here are only for the adult population. The main source of information is the work by Banerjee and Sen [18], who have studied the above parameters in a group of male and female subjects with mean body weight of 52.5 Kg. In addition to the data by these workers, another group of workers (Vyas et al) [19] have measured the blood volume for two sets of populations belonging to higher and lower socio-economic groups with distinctly different body weights. Avadhani and Shetty [42] have reported values of lean body mass, they have also determined the total body water in the adult population using the ethanol dilution method. These data are presented in Table 10 along with the data on skeleton weight, total body fat and mean weight of minerals for the adult population group.

TABLE XI. PROPOSED BODY COMPOSITION OF REFERENCE INDIAN MAN

Parameter	Male	Female
1. Lean Body Mass (kg)	45 (58.0)	38 (43.0)
2. Body Fat (kg)	6.8 (13.5)	5.5 (16.0)
3. Blood Volume (l)	3.9 (5.2)	3.3 (3.9)
4. Total Body Water (l)	31.5 (42)	27 (29)
5. Minerals (kg)	3.1 (4.1)	2.8 (-)
6. Skeleton Weight (kg)	7.0 (10)	6.0 (6.8)

1. This data has been arrived at using the body weight fractions for some of these body components.

2. The values given in parenthesis are for ICRP Reference Man

3. The values for Indian adult are proposed for 52.5 and 45 Kg male & female

Most of these parameters bore fixed ratio to the weight of the subjects. The body weight ratio of some of these parameters were employed to arrive at the proposed body composition of Reference Indian Man (Table 11), with 52.5 Kg and 45 Kg body weights for male and female subjects. The ICRP data are also included in Table 11 for comparison purposes and are shown in parenthesis. Although most of the body composition parameters are lower than those for the ICRP data [1] for the caucasian population, in the ratio of the body weight, yet for the average Indian, the fat content is lower than the caucasian population by a factor of 2. Much lower body fat content can be explained in terms of much lower dietary intake of fat (25% of that for the caucasians).

Water Balance

The information on the daily intake of water is important 1) for calculating the permissible radioactivity in water, and 2) in the study of the half-life of the important radionuclide ^3H as shown in the work of Dang et al [43]. The total excretion of water is through faeces, urine, sweat and insensible water loss (through moisture in breath and skin pores). The total intake and excretion of water determines the water balance in the human body.

The intake of water by Indian population (adult age group) has been studied by Raghunath and Soman [4] and also by ICMR [44]. The daily water excretion study was carried out by ICMR [44] and also by Dang et al [45]. The two studies on daily water consumption show that average adult in India consumes 4.5 L of water through different sources (Table 12). This consumption value is 1.5 times higher than that reported for ICRP Reference Man.

TABLE XII. WATER BALANCE STUDIES ON ADULT INDIAN POPULATION

Population group	No. of subjects	Water Intake (l)				Total
		Drinking water	Fluids Tea/coffee	Meal Preparation	Water of oxidation	
BARC middle income (Bombay)						
Male	81	1.68±0.49	0.95±0.23	1.6	0.3	4.5
Female	20	1.16±0.27	0.95±0.2	1.2	0.3	3.6
Low income group (Calcutta)		Drinking water + fluids		Meal preparation		
Spring (M)	4	1.45		2.19		3.64
Summer (M)	7	3.57		1.89		5.46
Winter (M)	6	2.05		1.46		3.51
Total Mean (M)	17	2.36		1.85		4.2

Water Excretion Data

Population group	Excretion routes			Insensible water loss
	Feces	Urine	Sweat	---
BARC middle income	---	2.0	---	
Low income group from Calcutta	0.2	2.16	---	

TABLE XIII. PROPOSED WATER BALANCE FOR REFERENCE INDIAN MAN (ADULT GROUP)

Daily Intake (l)		Daily Excretion (l)	
Sources	Volume	Routes	Volume
Drinking water	1.8	Urine	2.0
Milk	0.1	Feces	0.2
Hot beverages Tea/coffee	0.7	Sweat	1.1
Daily meal preparation	1.6	Insensible loss (Moisture in breath, etc.)	1.1
Water of oxidation	0.3		

TABLE XIV. DAILY AVERAGE INTAKE OF PRINCIPAL NUTRIENTS (g/cu/d)

Nutrient	Intake by population (adult)		
	Rural	Urban	National
Protein (g)	62	59	61.2
Fat (g)	24	45	29
Energy (kCal)	2283	2240	2272
Calcium (g)	0.556	0.632	0.575

Data reported here is on the basis of intake per consumption unit per day

TABLE XV. AVERAGE INTAKE OF FOODSTUFF (g/cu/d)

Food component	Intake in area		
	Rural (1988-90)	Urban (1975-79)	National average
Total cereals & millets	490	405	469
Pulses	32	42	35
Total Vegetables	60	78	65
Roots & tubers	40	70	48
Nuts & oilseeds	8	14	10
Condiments & spices	13	14	14
Fruits	13	44	20
Flesh foods	12	21	14
Milk	96	133	100
Fats & oils	13	24	15
Sugar & jaggery	29	28	29

The fluid intake was found to vary with the season, being highest in summer and lowest in winter, as shown in Table 12. For Indians, the major source of water intake is the drinking water itself, followed by water required for the preparation of the daily meals. The daily intake of fluids by female population was obtained to be 0.75 times the intake by male adult.

The excretion of water is mainly through urine, which is about 2.2 L (range: 0.6 - 3.1 L) followed by loss through sweat and insensible water loss through the moisture in breath and invisible water loss through the skin pores. The urinary excretion and the sweat rate are known to vary with the atmospheric temperature and with the season. In winter, the urine excretion was found to be 2.2 L and in summer it was obtained to 1.3 L for an urban population group (Dang et al) [45].

The proposed water balance data for Reference Indian Man (RIM) including both the intake and excretion values, is shown in Table 13.

TABLE XVI. PER CAPITA INTAKE OF PROTEIN (g) AND CALORIE (kcal) IN DIFFERENT AGE GROUP OF RURAL POPULATION

Age group (years)	Protein Intake (g)	Calories (kCal)
1	12.6	504
2	22.1	756
5	28.8	1080
12	40.0	1407
13-16 (M)	45.1	1600
(F)	41.0	1540
16-18 (M)	54.6	1920
(F)	44.5	1694
Adult Male	54.5	2042
Adult Female	45.9	1725

TABLE XVII. AVERAGE DAILY CONSUMPTION OF FOOD COMPONENTS BY YOUNGER INDIAN POPULATION - (g)

Age (Years)	Food components						
	Cereals	Pulses	Vegetables	Fruits	Flesh & eggs	Milk (ml)	Fat & Oil
2	176	14	31	18	6	68	5
5	263	21	51	23	7	62	7
12	400	35	62	-	-	110	18
15 (M)	440	30	70	-	-	90	18
15 (F)	-	-	-	-	-	90	-

METABOLIC PARAMETERS

The daily intake of principal nutrients for rural and urban groups, along with the weighted mean values of national average for adult population are shown in Table 14. The data on the national average is obtained by giving appropriate weight for the population distribution in the rural and urban areas of the country. The intake data are reported in terms of consumption units (CU).

The consumption unit (CU) is the coefficient for computing calorie requirement for different groups of Indian population. The CU values for adult sedentary worker is taken as 1.0 and for moderate and heavy worker the CU values are taken as 1.2 and 1.6 respectively. Similarly, the CU values for female workers in different groups are 0.8, 0.9 and 1.2 respectively.

TABLE XVIII. PERCENTAGE OF TOTAL CALORIES DERIVED FROM VARIOUS FOOD INGREDIENTS FOR INDIAN POPULATION IN DIFFERENT AGE GROUPS

Food Ingredient	Percentage calories contributed in each age group (y)						
	1-3	3-5	5-7	7-9	9-12	12-18	Adult
Cereals	66	76	77	80	80	84	81
Pulses	6	5	5	5	5	4	5
Milk & milk products	13	8	7	5	5	4	5
Sub Total	85	89	89	90	90	92	91
Sugar & jaggery	7	5	7	6	6	4	5
Fats & Oils	5	3	2	2	2	1	1
Veg. & fruits	3	3	3	3	3	3	3

Major percentage of calories 85-92% are supplied by cereals, pulses and milk products.

TABLE XIX. AVERAGE DAILY INTAKE OF A FEW SELECTED ELEMENTS BY INDIAN POPULATION IN DIFFERENT AGE GROUPS

Element	Daily intake at different ages (y)				
	2	5	12	15	Adult
Ca(g)	0.24	0.29	0.31	0.36	0.40
Na(g)	Main contribution from salt				5.9
K(g)	0.8	0.95	1.2	1.6	1.8
Mg(g)	0.25	0.3	0.4	0.5	0.5
S(g)	0.32	0.45	0.55	0.62	0.6
P(g)	0.6	0.9	1.1	1.3	1.3
Cu(mg)	0.6	0.9	1.6	1.8	2.2
Zn(mg)	4.6	5.0	7.2	8.5	10.3
Mn(mg)	1.8	2.8	4.0	4.5	5.1
Fe(mg)	8.9	11.8	15.0	20.0	19.0
Co(μg)	6.0	9.0	13.2	16.0	16.0
Cr(μg)	45.	70.	95.	120.	130.
Se(μg)	48.	67.	97.	110.	110.
Cs(μg)	3.5	5.1	7.0	8.5	9.0

The intake was obtained by the analysis of individual food components.

TABLE XX. THE COMPARISON OF DAILY DIETARY ELEMENTAL INTAKE BY ADULT INDIAN, JAPANESE & ICRP

Element	India	Japan	ICRP
Ca(g)	0.4	0.55	1.1
Na(g)	5.9	5.2	4.4
K(g)	1.8	2.0	3.3
Mg(g)	0.5	0.21	0.34
S(g)	0.6	-	0.85
P(g)	1.3	1.0	1.4
Cu(mg)	2.2	1.3	3.5
Zn(mg)	10.3	7.6	13.0
Mn(mg)	5.1	4.5	3.7
Fe(mg)	19.0	11.0	16.0
Co(μg)	16.0	-	300.
Cr(μg)	130.	180.	300.
*Mo(μg)	105.	-	200.
Se(μg)	110.	-	150.
I(μg)	250.	-	200.
Cs(μg)	9.0	-	10.
*Th(μg)	2.2	0.4	3.0
*U(μg)	0.8	0.7	1.9

(* Data for urban population)

TABLE XXI. INTAKE OF PRINCIPAL NUTRIENTS BY INDIAN INFANTS

Age (months)	Intake of Nutrients			
	Protein (g)	Fat (g)	Calories (kCal)	Calcium (g)
1 - 2	6.5	20.0	384	0.16
4 - 6	7.6	23.5	450	0.19

The data on the daily intake of various food components such as cereals, pulses, total vegetables, fruits, flesh foods, milk, fat and oils etc., are shown in Table 15. These data are also shown for rural, urban and national average values and are in consumption units. The urban data was arrived at by giving due weight to the population distribution in different socio-economic groups in urban areas along with the consumption pattern in those different groups. National average is finally computed by using intake pattern by rural and urban population along with the population distribution in the two areas.

These data on the intake of principal nutrients and food components were obtained essentially from the extensive surveys at the national levels, two of them for the rural population (NNMB Reports, 1980 and 1988-90) [8-9] and one for the urban (NNMB Report, 1984) [7].

When the intake of principal nutrients by adult population (Indian) is compared with the intake data for ICRP [1] and Japanese [Tanaka, 1988; Kawamura and Tanaka, 1992) [46-47] Reference Man, it was observed that the Indian adult consumes less protein and calories. The intake of fat is also much lower for an average Indian. These factors could explain the lower average body weight for height in the case of the Indian population in different age groups.

The per capita intake of protein and calories for different age groups of rural Indian populations are shown in Table 16. The intakes for 1, 2, 5, 12y age groups are given for mixed population, whereas for the age groups 13-16y, and 16-18y, and adult population the data are reported for male and female populations separately. It is clear from the data that the intake of both these nutrients increase with age, but the intakes of both protein and calories in the 16-18y and adult are comparable. The intakes reported here are on a per capita basis and not in consumption units. Although the per capita intakes of protein and calories reported in this table are for rural populations, the intake values for the urban population are not likely to be much different, as indicated from the calorie intake data per CU for the two population groups.

The major amount of energy (calories) for the Indian population in different age groups is derived from cereals, followed by pulses and then milk. Table 18 shows the percentage of total calories derived from various food components, for the population groups in the age range 1-3, 3-5, 5-7, 7-9, 12-18 and adult. As is clear from the Table, more than 85% of the total calories consumed are derived from cereals, milk and pulses and only a smaller percentage of calories are supplied by other food components.

Trace Element Intake

The intake of various trace elements by the Indian population groups in 2, 5, 12, 15y and adult were obtained by the trace element analysis of the individual food items, using the two analytical techniques of neutron activation analysis (NAA) and atomic absorption spectrophotometry (AAS), and from the amounts of individual food components consumed by different population groups. The reliability of the two analytical techniques for the trace analysis was tested by the analysis of Reference Materials with known concentrations of trace elements in them.

The intake of fourteen trace elements, Na, K, Ca, Mg, Cu, Zn, Fe, Se, Co, Cr, Cs, S and P by the Indian population in different age groups are given in Table 19. The analysis of the elements Ca, Mg, Na, K, Cu, Zn, Fe and Mn were carried out using AAS technique and for Fe, Co, Se, Cs, Cu and Zn, NAA technique was employed. The concentrations of S and P in different food components were obtained from the report on nutritive values of Indian foods [48].

The intake for a few more important elements such as Th, U, I were also obtained but only for the adult population group. Table 20 shows the comparison of the daily intake of

TABLE XXII. DAILY INTAKE OF A FEW SELECTED TRACE ELEMENTS BY BREAST FED INDIAN INFANTS

Age of Infant	Daily Intake								
	Cu (mg)	Zn (mg)	Fe (mg)	Mn (µg)	Co (µg)	Mo (µg)	Se (µg)	As (µg)	Hg (µg)
0 - 1 week	0.27	2.07	0.34	4.95	0.36	7.29	14.8	0.27	0.14
1 - 2 month	0.20	1.27	0.38	4.75	0.35	5.32	14.8	0.40	0.17
2.5 - 3.5 month	0.16	0.98	0.45	4.62	0.41	5.51	15.7	0.40	0.16

(1) Dang et al. (1983)
(2) Dang (1984)
(3) Dang et. al. (1984)

TABLE XXIII. ELEMENTAL COMPOSITION OF COMMERCIAL MILK POWDERS (RANGE OF VALUES)

Element	Unit	Concentration in powder	Concentration in reconstituted milk
Ca	µg/g	8200 - 33700	1170 - 4814
Na	"	4500 - 5400	643 - 771
Mg	"	680 - 850	97 - 121
Zn	"	23.5 - 39.1	3.4 - 5.6
Fe	"	8.3 - 75.0	1.2 - 11.0
Cu	"	0.9 - 9.4	0.1 - 1.3
Se	ng/g	354.6 - 818	52 - 117
Mn	"	258 - 465	37 - 66
Mo	"	66 - 114	9 - 16
Co	"	3.8 - 15.3	0.5 - 2.0
As	"	8.0 - 15.4	1 - 2
Hg	"	2.8 - 4.4	0.4 - 0.6

The reconstituted milk is prepared by mixing 30 g of powder in 200 ml of water.

trace elements by Reference adult population of India, Japan [47] and ICRP Reference Man [1] representing the caucasian population. The intake of elements Ca, K, Cu, Zn, Co, Cr, Mo, Th and U are lower for the Indian population when compared with the corresponding figures of ICRP Reference Man, whereas intakes of Na, Mg, Mn, Fe were found to be higher for Indians. The higher intake of Na and Mg could be due to increased requirements as the sweat rate is higher. Mn and Fe intake could be higher due to larger cereals component in diet which are rich in these two elements. The Co intake reported by ICRP is much higher and needs to be revised. The analysis of some of the standard US and European diets gave an estimated daily intake of about 20-30 microgram by European and US population groups. The elemental intake by the Indian population is generally comparable to that for the Japanese population.

Daily Intake of Nutrients by Infants in Early Stages of Life

The only source of nutrition for Indian infants through the first 4-6 months of life is the mothers milk. The intakes of nutrients such as protein, fat and calories in early stages of life could be easily estimated once the intake of milk is known. The values of nutrients in mothers milk are provided in NIN report on nutritive values of Indian foods [48]. Similarly, the intake of micronutrients such as trace elements in mothers milk along with the average intake of milk is known. Dang (1984) [49] has studied the daily intake of milk by Indian infants in the age groups 1-2 months and 4-6 months by test weighing method. The daily intake of milk for the two age groups was 0.59 ± 0.06 and 0.69 ± 0.09 L respectively. The results on daily milk intake obtained by Dang et al., were supported by similar studies [50-51].

Using the data on protein, fat, calorie and calcium for the 1-2 m and 4-6 m, the daily intake of these nutrients for two age groups is shown in Table 21.

The daily intake of trace elements during the first week and also in two other age groups - 1-2 m and 2.5 - 4.5 m were obtained. The intake reported in this table is for the elements Cu, Zn, Fe, Mn, Co, Mo, Se, As and Hg. These data were obtained by using the trace element concentrations determined by Dang et al [52-54], using neutron activation analysis for the breast milk obtained at different stages post partum. The results are reported in Table 22.

It was observed that generally the first milk (colostrum) had a few times higher concentration of most of the elements. Therefore the intake of elements such as Cu, Zn, Mn, Mo, is higher in the first week of life, although the volume of milk consumed is lower.

Although human milk is the ideal food for infants, many infants are fed on commercial milk, because either the mother is not able to lactate or she has to go to work. In that case the trace element supply to the infants depends upon the trace element concentrations in the commercial milk formulae. The range of concentrations of a number of elements, Na, K, Ca, Mg, Cu, Zn, Mn, Fe, Se, Co, Mo, As and Hg in a few popular brands of milk formulae available in the market are reported in Table 23. The milk powders are generally diluted 7 times with boiled water to reconstitute fluid milk. The expected range of elemental concentrations in reconstituted milk are also reported in Table 23. It was observed in the work of Dang (1984) that, with the exception of Cu, Mo, As and Hg, most of the elements are higher in commercial milk formulae. The concentrations of Cu and Mo are lower in commercial formulae and those of As and Hg are comparable with those in breast milk.

Elemental Content of Body Organs

The elemental organ burdens for the adult population were obtained by carrying out the trace element analysis of a number of organ tissues obtained at autopsy performed on the healthy subjects who died from accidental deaths. The average concentrations of fifteen elements obtained on the basis of trace element analysis of organ tissues from 15-20 subjects

TABLE XXIV. COMPARISON OF THE ORGAN BURDENS FOR DIFFERENT ELEMENTS INDIAN AND ICRP REFERENCE MAN - (g)

Organ	Element							
	Na		K		Ca		Mg	
	1	2	1	2	1	2	1	2
Heart	0.30	0.40	0.54	0.72	0.009	0.012	0.033	0.054
Kidney	0.60	0.62	0.44	0.59	0.025	0.029	0.023	0.040
Liver	1.8	1.8	2.7	4.5	0.68	0.67	0.13	0.31
Lungs	1.8	1.8	1.3	1.9	0.10	0.09	0.067	0.071
Muscle	12.	21.	33.0	84.0	1.0	0.9	2.3	5.3
Brain	2.0	2.5	3.4	4.2	0.12	0.12	0.27	0.27
Skeleton	15.6	32.	9.5	15.0	680.	630.	3.4	11.0

1. Data for Indian Reference Man
2. Data for ICRP Reference Man.

TABLE XXV. COMPARISON OF THE ORGAN BURDENS FOR DIFFERENT ELEMENTS INDIAN AND ICRP REFERENCE MAN (g)

Organ	Element							
	P		Zn		Fe		Cu	
	1	2	1	2	1	2	1	2
Heart	0.38	0.48	0.0046	0.0084	0.012	0.015	0.0005	0.0011
Kidney	0.36	0.50	0.007	0.015	0.011	0.023	0.00044	0.00094
Liver	2.5	4.7	0.047	0.085	0.10	0.32	0.006	0.012
Lungs	0.80	0.78	0.009	0.011	0.18	0.36	0.0009	0.0012
Muscle	--	--	0.72	1.5	0.7	1.1	0.018	0.025
Brain	2.3	4.8	0.019	0.017	0.056	0.074	0.006	0.0081
Skeleton	310.	700.	0.16	0.48	0.23	0.8	0.0075	0.0072

1. Indian Reference Man Data
2. ICRP Reference Man Data

TABLE XXVI. COMPARISON OF THE ORGAN BURDENS FOR DIFFERENT ELEMENTS INDIAN AND ICRP REFERENCE MAN - (g)

Organ	Element							
	Mn		Co		Se		Hg	
	1	2	1	2	1	2	1	2
Heart	6.9 · E-5	6.6 · E-5	7.6 · E-6	10.0 · E-6	2. · E-5	8. · E-5	1.2 · E-6	4.5 · E-5
Kidney	1.7 · E-4	2.8 · E-4	3.0 · E-6	4.0 · E-6	--	--	--	8.7 · E-5
Liver	1.6 · E-3	2.5 · E-3	1.1 · E-4	1.1 · E-4	4.6 · E-4	1.2 · E-3	1.2 · E-5	5.5 · E-4
Lungs	3.0 · E-4	1.2 · E-4	3. · E-5	2. · E-5	1.7 · E-4	1.8 · E-4	1.2 · E-6	5.8 · E-4
Muscle	4.0 · E-3	1.5 · E-3	1.3 · E-4	2. · E-4	4.2 · E-3	5.0 · E-3	4.0 · E-5	4.2 · E-3
Brain	1.1 · E-4	3.9 · E-4	--	--	--	--	--	--
Skeleton	3.0 · E-3	5.2 · E-3	2.4 · E-4	3. · E-4	2.8 · E-3	--	5.2 · E-5	--

1. Indian Reference Man Data
2. ICRP Reference Man Data

TABLE XXVII. COMPARISON OF THE ORGAN BURDENS FOR DIFFERENT ELEMENTS INDIAN AND ICRP REFERENCE MAN

Organ	Element					
	Cs		La		Sb	
	1	2	1	2	1	2
Heart	1.4 · E-6	2.8 · E-6	2. · E-5	--	0.28 · E-6	2.2 · E-6
Kidney	1.9 · E-6	2.3 · E-6	1.6 · E-4	--	0.013 · E-5	9.3 · E-5
Liver	1.0 · E-5	2.0 · E-5	1.4 · E-4	--	0.03 · E-4	3.6 · E-4
Lungs	1.0 · E-5	6.0 · E-6	3.9 · E-3	--	4.3 · E-5	6.0 · E-5
Muscle	3.2 · E-4	5.7 · E-4	--	--	4.4 · E-5	--
Skeleton	4.0 · E-5	1.6 · E-4	--	--	0.012 · E-3	2.0 · E-3

1. Indian Reference Man Data
2. ICRP Reference Man Data

were employed along with the organ weight for proposed Reference Indian Man, to arrive at the elemental organ burdens. For the elemental analysis, the two techniques of neutron activation analysis (NAA) and atomic absorption spectrophotometry (AAS) were employed. The results of organ burdens for different elements are given in Tables 24-27, along with the corresponding burdens reported by ICRP [1] for the caucasian population. The data reported in these tables are only for adult males.

The elemental organ burden for the Indian population are expected to be lower that those for ICRP Reference Man, because of the small organ weights and have been found to be so. However, in a few exceptional cases, they were comparable or marginally higher, for example, Mn, Cs, etc., which may be due to more dust in the tropical environment. Again, the organ burdens of Hg for Indian population were much lower than those for the ICRP Reference Man. The mercury burdens for ICRP Man appear to be quite high and need to be reconfirmed by generating more data for caucasian populations.

CONCLUSIONS

Collection, collation and generation of anatomical, physical, physiological and metabolic data were carried out with a view to developing Reference Indian Man (RIM), a human model for application in strengthening radiation protection in India and also in other Asian countries.

The Indian population is distributed in different socio-economic groups, religions, ethnic groups, areas etc. The human parameters such as physical features, dietary intake, physiological standards were found to be different for different groups. Every effort was made in the course of this study to give due weight to the population distribution in different groups, while arriving at the representative Reference Indian Man data.

The physical parameters such as body weight, height, the metabolic parameters like intake of principal nutrients and also most of the physiological parameters for an average Indian were smaller than those of the ICRP Reference Man. A few parameters such as the daily intake of drinking water and fluids which depend upon the climatic conditions were larger for an average Indian.

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ANTHROPOLOGICAL CHARACTERISTICS, INTERNAL ORGANS MEASUREMENTS, AND FOOD CONSUMPTION OF INDONESIAN PEOPLE, 1989-1993

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Abstract

This study has been conducted to obtain, assess and interpret data on morphological, anatomical, chemical and metabolic characteristics of Indonesian population of all ages for establishing an Indonesian Reference Man. The paper presents age and sex specific data on physical anthropometric measurements, and on weights and dimensions of internal organs of normal and healthy Indonesian people. In addition, the content of selected elements in main organs and foodstuff, and the data of daily food consumption of well nourished individuals in three different regions of Indonesia are also presented.

Approximately 804 people of all ages were measured to obtain the physical/anthropometric data. The people chosen were from 3 Indonesian regions representing the middle class socio-economic population. The average body weight and total body height of the age group 20-39 years were found to be 53.5 kg (range: 40-70 kg) and 160.4 cm (range: 147.3-179.8 cm) for males and 48.9 kg (range: 32.7-79.5 kg) and 150.9 cm (range: 141.8-167.3 cm) for females.

The weights and dimensions of internal organs data were collected in Jakarta from about 155 sudden death victims. The weight of most male organs was generally about 1% to 19% larger than those of females. However, the female thyroid was 5.6% larger than the males.

The age specific food consumption were obtained in three regions of Indonesia. The content of elements in the selected foodstuffs are also included in this report. The results show that rice is consumed three times a day by most subjects. Milk and eggs are widely consumed and the intake tends to be higher in the younger age groups. Among the meat group, beef is the most popular and consumed with the highest frequency, followed by chicken both in popularity and quantity consumed. Vegetables, particularly the colored vegetables, are used daily in high amounts.

INTRODUCTION

Specific data for Asian countries were excluded in the ICRP Report on Reference Man (Publication 23, 1975) needed for the radiation protection purposes and dose estimation. This study was conducted to compile data necessary to characterize Reference Asian Man, and provide the ICRP Reference Man Task Group with information on the characteristics of the

Asian population for revision of ICRP Publication 23. The main objective of the study has been to obtain, assess and interpret data on morphological, anatomical, chemical and metabolic characteristics of Indonesian population of all ages for establishing an Indonesian Reference Man in particular and an Asian Reference Man in general.

Most of the data obtained in the study were collected from the people of Jakarta, where the highest degree of urbanization and most ethnic intermarriages have taken place. The study covered males and females from newborn to more than 60 years old. These measurements are expected to represent a "cross section" of the Indonesian population. The Indonesian people live throughout the 5 main islands in the country including a large number of tribes and ethnic groups.

This paper reports age and sex specific data on physical anthropometric measurements, and on weights and dimensions of internal organs of normal and healthy Indonesian people. In addition, the content of selected elements in main organs and foodstuff, and the data of daily food consumption of well nourished individuals in three different regions of Indonesia are also presented.

MATERIAL AND METHOD

Approximately 804 people (43% male, 57% female) of all ages were measured to obtain the physical/anthropometric data. The people chosen were from North Sumatra (west Indonesia), Jakarta (middle Indonesia), and East Timor (east Indonesia) representing the middle class socio-economic level. All of them were healthy and free from hereditary and chronic diseases. The methods used for these measurements have been reported in detail in the previous report.

The weights and dimensions of internal organs data were collected in Jakarta from about 155 sudden death victims (77% male and 23% female) in a range from 10 to 72 years old. The autopsy data dealt with unnatural deaths of subjects who were believed to be living normal daily lives until shortly before their deaths. The autopsies were conducted by standard procedures in Indonesia, and organs were weighted and measured after being cleaned. In addition, the elemental content in the organs was analyzed using Atomic Absorption Spectrometry. The samples were taken from 20 males of ages 19-52 years.

The daily food consumption data of healthy and different age groups were carried out in three different regions of Indonesia (west Indonesia, middle Indonesia and east Indonesia). The dietary data were collected by interviews using the pretested, guided questionnaires. The average intake of food is expressed in grams/person/day per age group of raw but edible material. Furthermore, the content of elements in several foodstuffs was analyzed by Atomic Absorption Spectrometry. The frequency of consumption of the various foodstuff presenting the pattern of Jakarta people was calculated and expressed in percentage.

RESULT AND DISCUSSION

Sex specific data on 24 physical/anthropometric parameters of normal Indonesian people in 9 age groups ages are presented in Table 1 and Figures 1-4. The number of samples in the age groups < 12 months, 1-3, 4-6, and 7-9 years, is small but still reported. Based on the present work, the average body weight and total body height of the age group 20-39 years are respectively 53.5 kg (range: 40-70 kg) and 160.4 cm (range: 147.3-179.8 cm) for males and 48.9 kg (range: 32.7-79.5 kg) and 150.9 cm (range: 141.8-167.3 cm) for females. The data compiled are not sufficient to represent the whole population of Indonesian people. These

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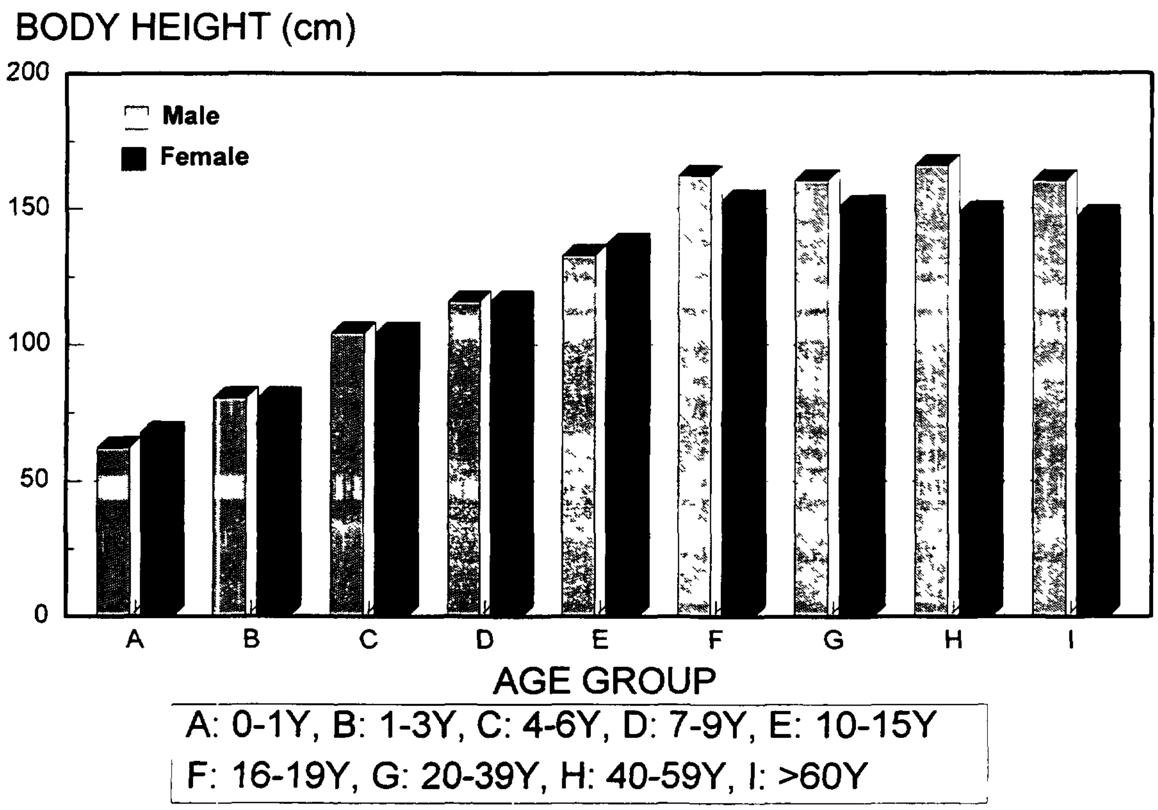

FIG. 1. Body height by age group.

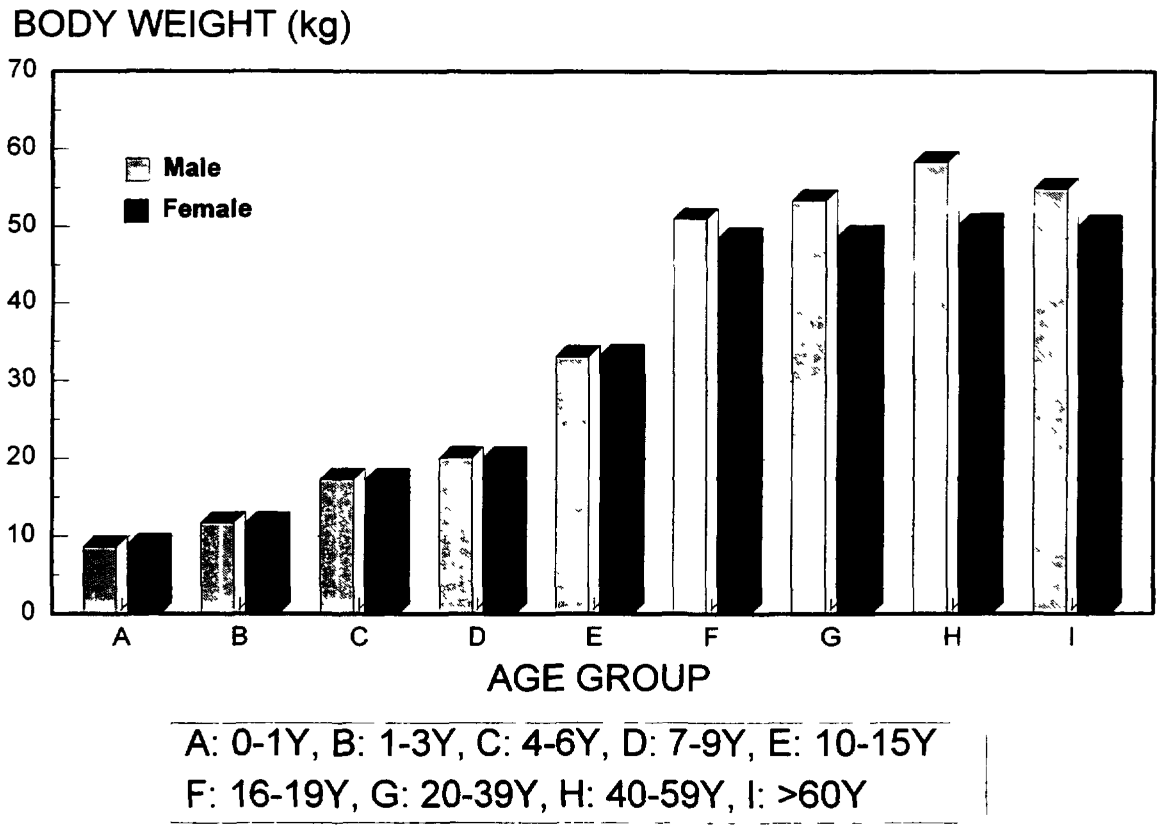

FIG. 2. Body weight by age group.

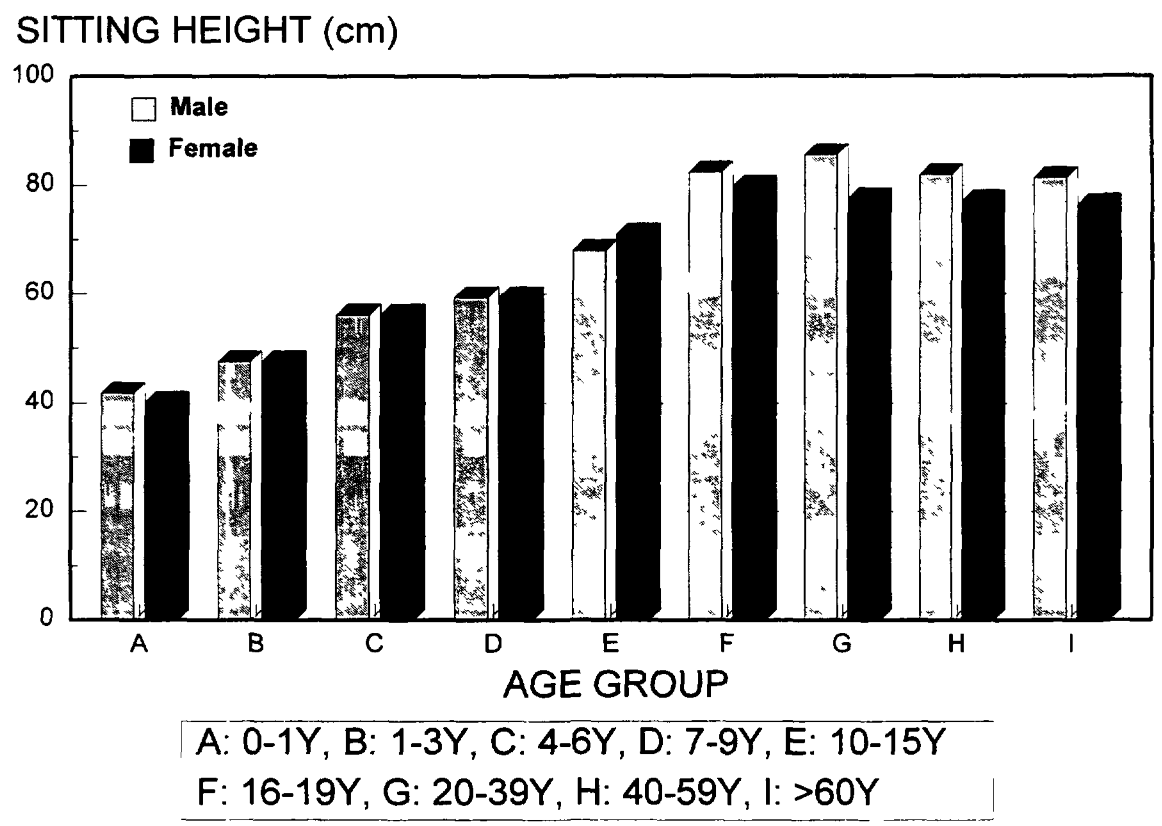

FIG 3. Sitting height by age group.

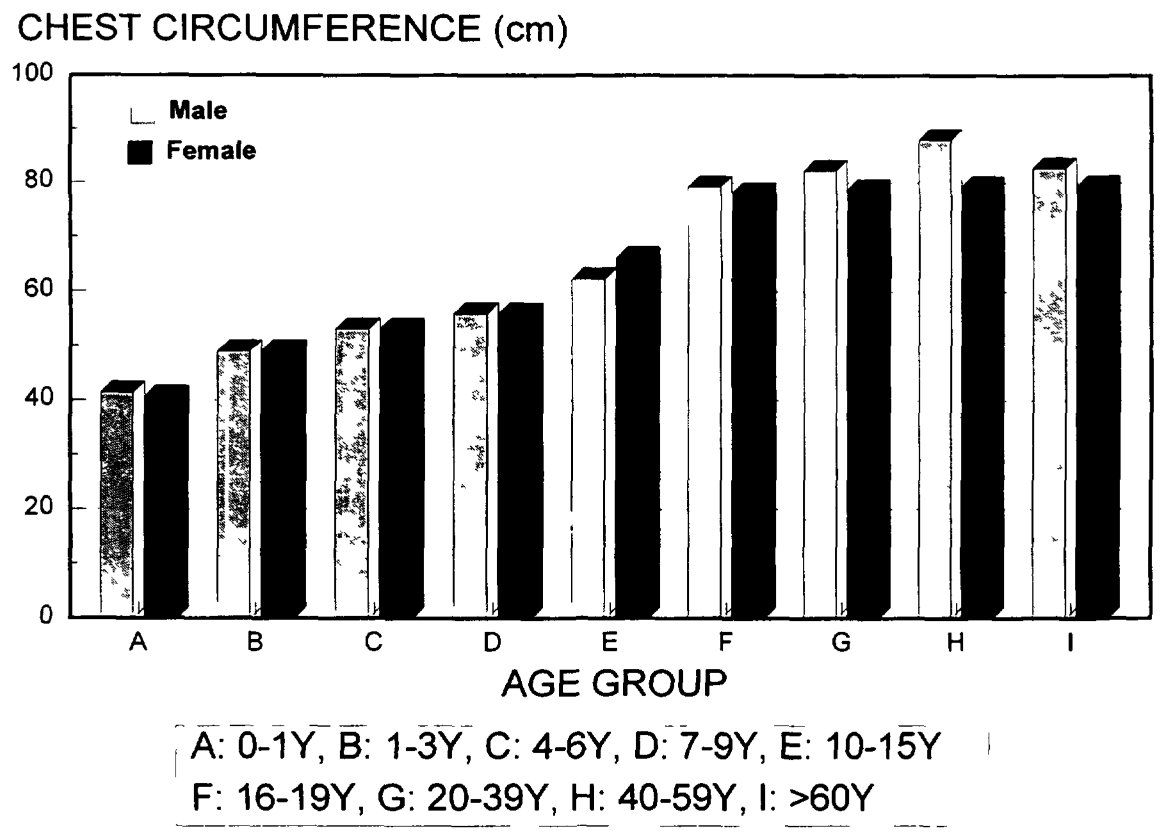

FIG. 4. Chest circumference by age group.

TABLE I. AGE AND SEX SPECIFIC ANTHROPOMETRIC MEASUREMENTS OF INDONESIAN POPULATION SAMPLE

No.	Age (yrs)	Sex (n)	Body weight (kg) (range)	Total body height (cm) (range)	Sitting height (cm) (range)	Height of head and neck (cm) (range)	Height of head (cm) (range)	Head circumference (cm) (range)
1.	< 12 months	M (3)	8.6 (5.0-11.0)	62.2 (59.0-77.5)	41.7 (38.6-45.5)	15.2 (13.4-18.4)	-	42.4 (41.0-47.5)
		F (4)	8.9 (5.5-10.0)	67.8 (62.0-70.6)	40.1 (77.4-44.5)	16.8 (15.5-18.0)	-	42.1 (40.1-43.5)
2.	1 - 3	M & F (10)	11.7 (6.0-15.5)	80.4 (58.1-98.4)	47.5 (43.2-51.2)	20.4 (13.6-26.0)	11.4 (9.2-13.0)	44.6 (40.0-47.0)
3.	4 - 6	M & F (20)	17.3 (12.0-21.7)	104.2 (85.6-138.8)	56.1 (48.2-61.4)	20.7 (12.5-24.5)	14.3 (9.2-16.0)	48.6 (44.0-51.0)
4.	7 - 9	M & F (20)	20.1 (16.0-28.0)	115.8 (107.8-131.3)	59.3 (48.0-66.9)	22.9 (20.0-25.5)	15.0 (13.0-16.8)	50.5 (47.5-52.5)
5.	10 - 15	M (72)	33.1 (16.0-56.0)	132.8 (107.8-160.0)	67.9 (57.5-86.0)	25.8 (20.5-30.1)	13.6 (13.0-15.8)	51.9 (47.5-56.3)
		F (83)	33.3 (17.3-49.1)	137.0 (114.8-158.6)	71.0 (57.1-85.0)	26.4 (20.9-29.0)	13.7 (13.1-15.8)	51.6 (49.0-55.0)
6.	16 - 19	M (58)	51.1 (36.3-68.7)	162.0 (143.6-179.8)	82.4 (73.3-92.8)	31.6 (24.9-36.5)	14.6 (14.2-15.2)	55.1 (53.0-59.1)
		F (65)	48.6 (32.4-62.0)	153.0 (141.7-168.0)	79.8 (71.8-91.1)	29.2 (24.2-33.1)	14.1 (13.6-15.2)	53.5 (42.7-57.0)
7.	20 - 39	M (190)	53.5 (40.6-70.0)	160.4 (147.3-179.8)	85.5 (46.2-95.4)	31.1 (28.0-36.5)	14.7 (14.2-15.2)	54.7 (35.2-59.4)
		F (198)	48.9 (32.7-79.5)	150.9 (141.8-167.3)	77.5 (41.5-89.6)	28.6 (25.0-33.8)	-	53.9 (42.7-58.0)
8.	40 - 59	M (83)	58.4 (32.5-99.0)	165.9 (147.0-172.0)	81.9 (73.9-89.1)	29.3 (24.9-33.8)	13.9 (13.1-14.7)	55.3 (51.0-58.5)
		F (60)	50.4 (31.2-76.1)	148.6 (137.9-158.8)	77.1 (69.7-87.1)	27.2 (20.3-30.6)	14.0 (13.2-15.1)	53.8 (51.0-57.1)
9.	> 60	M (18)	55.0 (41.3-72.7)	160.3 (143.8-169.4)	81.3 (72.3-85.6)	29.6 (27.2-32.0)	15.0 (14.4-15.5)	53.7 (36.8-56.5)
		F (20)	50.2 (34.0-64.7)	147.1 (129.5-160.5)	76.4 (72.1-81.8)	26.9 (25.0-29.6)	15.0 (13.8-15.7)	54.7 (49.2-65.0)

TABLE I. AGE AND SEX SPECIFIC ANTHROPOMETRIC MEASUREMENTS OF INDONESIAN POPULATION SAMPLE (CONT.)

No.	Age (yrs)	Sex (n)	Length of head (cm) (range)	Head width (cm) (range)	Neck circumference (cm) (range)	Chest depth (cm) (range)	Chest width (cm) (range)	Mesosterna chest circum-ference (cm) (range)
1.	< 12 months	M (3)	-	12.2 (11.6-13.0)	25.0 (24.5-25.5)	-	-	41.4 (40.0-45.5)
		F (4)	-	11.6 (11.2-12.0)	25.4 (21.3-31.8)	-	-	40.7 (39.1-43.0)
2.	1 - 3	M & F (10)	15.4 (14.2-16.0)	13.5 (12.2-14.0)	24.3 (21.2-27.0)	12.6 (12.0-14.3)	15.8 (13.8-16.5)	49.0 (45.0-52.0)
3.	4 - 6	M & F (20)	16.1 (15.0-16.8)	14.0 (12.8-15.0)	25.7 (23.0-29.2)	12.9 (11.5-14.5)	17.2 (14.8-19.5)	53.1 (49.0-63.5)
4.	7 - 9	M & F (20)	15.3 (13.0-17.5)	13.5 (12.8-15.0)	25.0 (23.3-27.8)	13.0 (12.4-14.0)	17.8 (15.0-19.5)	55.9 (50.0-62.0)
5.	10 - 15	M (72)	15.5 (13.5-17.0)	14.3 (13.0-15.3)	27.6 (23.5-35.5)	14.0 (12.4-16.6)	20.0 (17.0-25.5)	62.3 (55.0-77.2)
		F (83)	16.5 (15.4-17.2)	14.3 (12.5-15.3)	27.4 (23.0-30.5)	13.3 (12.0-15.5)	18.2 (16.4-21.5)	66.1 (53.5-82.4)
6.	16 - 19	M (58)	17.4 (15.1-18.3)	14.7 (13.8-15.3)	32.9 (28.5-51.1)	15.8 (15.0-19.8)	24.8 (23.2-26.0)	79.2 (69.1-89.8)
		F (65)	15.2 (12.1-17.9)	14.5 (13.6-15.7)	30.2 (26.5-35.5)	15.9 (15.0-16.4)	23.5 (20.0-25.0)	78.0 (65.5-87.5)
7.	20 - 39	M (190)	17.1 (16.0-18.3)	14.9 (12.4-17.3)	33.1 (30.2-38.6)	17.3 (16.5-18.2)	25.7 (24.9-26.3)	82.2 (70.8-107)
		F (198)	16.4 (15.0-18.4)	15.1 (13.5-16.6)	29.9 (20.2-37.7)	15.8 (14.5-17.1)	24.5 (22.0-29.0)	78.6 (66.3-93.8)
8.	40 - 59	M (83)	16.4 (14.4-18.5)	14.2 (12.2-15.1)	33.8 (28.5-41.0)	20.3 (16.2-14.5)	26.9 (24.3-29.5)	88.0 (72.0-109)
		F (60)	17.8 (17.5-18.5)	14.7 (13.6-15.8)	30.2 (25.7-34.6)	17.5 (15.0-20.0)	24.1 (22.0-30.0)	79.2 (66.0-100)
9.	> 60	M (18)	18.1 (17.2-18.5)	15.1 (13.8-16.3)	36.8 (27.2-40.4)	18.2 (16.4-20.5)	25.8 (22.8-27.5)	82.7 (66.9-96.0)
		F (20)	17.5 (16.5-18.0)	14.2 (13.6-15.5)	30.8 (28.1-35.0)	16.9 (14.0-18.0)	24.6 (20.0-27.0)	79.3 (65.3-97.5)

TABLE I. AGE AND SEX SPECIFIC ANTHROPOMETRIC MEASUREMENTS OF INDONESIAN POPULATION SAMPLE (CONT.)

No.	Age (yrs)	Sex (n)	Length of arm (cm) (range)	Max. upper arm circum-ference (cm) (range)	Middle arm circumference (cm) (range)	Length of leg (cm) (range)	Max. thigh circumference (cm) (range)	Length of foot (cm) (range)
1.	< 12 months	M (3)	27.4 (25.2-30.2)	15.1 (14.8-16.0)	13.5 (12.0-14.5)	28.0 (25.5-29.5)	25.1 (24.5-26.0)	10.4 (8.6-12.8)
		F (4)	25.4 (21.5-27.5)	14.1 (13.6-15.4)	13.2 (13.0-13.8)	27.8 (24.5-30.0)	24.3 (22.4-25.0)	10.9 (10.2-11.8)
2.	1 - 3	M & F (10)	34.3 (29.0-38.0)	16.0 (13.4-18.0)	14.7 (12.8-16.0)	39.8 (31.0-47.0)	27.2 (25.0-33.0)	13.8 (11.0-16.0)
3.	4 - 6	M & F (20)	41.8 (33.0-39.0)	16.8 (15.0-19.5)	15.6 (14.0-19.0)	48.2 (37.0-57.0)	31.3 (24.5-37.5)	16.5 (12.5-19.5)
4.	7 - 9	M & F (20)	50.1 (44.5-57.0)	18.1 (16.4-21.2)	16.4 (14.2-19.0)	59.6 (52.0-72.5)	36.4 (32.2-38.6)	18.1 (15.1-20.0)
5.	10 - 15	M (72)	58.6 (44.5-89.3)	21.4 (15.7-29.0)	19.7 (14.8-28.0)	68.3 (55.0-88.5)	39.5 (31.0-51.0)	21.7 (16.0-26.0)
		F (83)	62.2 (49.7-87.0)	21.8 (12.1-31.1)	19.7 (12.3-25.0)	71.2 (41.1-82.2)	43.1 (26.0-57.0)	21.6 (17.8-26.7)
6.	16 - 19	M (58)	73.0 (64.2-89.3)	26.2 (19.4-29.0)	24.2 (18.4-28.0)	82.6 (66.4-91.6)	48.9 (39.6-58.2)	24.9 (22.0-26.5)
		F (65)	66.8 (46.7-82.0)	26.1 (18.5-30.0)	23.5 (19.0-28.5)	77.2 (67.1-88.9)	50.8 (40.1-59.2)	23.0 (20.2-27.5)
7.	20 - 39	M (190)	73.2 (64.1-80.7)	27.5 (22.6-38.7)	25.9 (21.7-35.0)	80.5 (68.2-91.8)	47.9 (42.4-68.2)	24.3 (21.2-27.5)
		F (198)	66.4 (54.0-85.6)	25.6 (20.7-32.9)	24.0 (17.7-32.4)	74.9 (65.2-90.7)	50.1 (40.1-66.7)	22.7 (18.7-26.6)
8.	40 - 59	M (83)	73.1 (65.7-83.4)	29.1 (21.0-42.0)	26.9 (20.5-35.0)	80.7 (67.2-95.5)	48.8 (37.0-68.0)	24.7 (21.6-27.9)
		F (60)	66.0 (58.0-74.5)	26.5 (20.6-36.2)	24.5 (20.0-32.1)	73.4 (65.7-84.5)	49.4 (40.3-64.3)	22.7 (17.4-31.5)
9.	> 60	M (18)	69.7 (67.0-75.8)	27.1 (24.5-32.0)	26.1 (22.5-31.5)	84.7 (78.3-90.0)	49.1 (40.1-61.1)	25.7 (22.8-34.6)
		F (20)	64.8 (59.0-74.0)	27.6 (20.0-33.4)	25.4 (19.0-30.8)	76.7 (65.5-86.3)	49.8 (41.5-59.0)	23.0 (21.8-25.0)

TABLE I. AGE AND SEX SPECIFIC ANTHROPOMETRIC MEASUREMENTS OF INDONESIAN POPULATION SAMPLE (CONT.)

No.	Age (yrs)	Sex (n)	Ankle circumference (cm) (range)	Triceps skinfold (mm) (range)	Biceps skinfold (mm) (range)	Sub-scapular skinfold (mm) (range)	Abdominal skinfold (mm) (range)	Suprailiacal skinfold (mm) (range)
1.	< 12 months	M (3)	12.1 (10.5-13.7)	9.1 (7.2-12.0)	5.8 (4.4-12.8)	7.6 (6.0-9.4)	6.8 (5.4-9.0)	7.1 (5.0-11.0)
		F (4)	12.7 (11.8-13.5)	8.7 (6.2-9.8)	4.5 (5.4-6.2)	6.2 (5.2-7.4)	4.1 (3.2-5.1)	6.7 (4.8-11.6)
2.	1 - 3	M & F (10)	14.7 (12.8-16.0)	9.4 (7.6-13.0)	6.7 (3.6-10.4)	6.1 (5.0-8.0)	6.6 (4.4-10.2)	7.6 (4.4-11.6)
3.	4 - 6	M & F (20)	15.8 (13.5-20.0)	8.6 (5.0-16.0)	6.4 (3.6-15.0)	6.4 (4.4-10.8)	6.2 (3.8-12.2)	6.2 (3.2-11.8)
4.	7 - 9	M & F (20)	17.5 (13.9-21.5)	7.9 (6.0-12.0)	5.2 (3.0-7.4)	5.4 (4.0-6.8)	5.7 (3.0-10.4)	5.5 (2.5-9.0)
5.	10 - 15	M (72)	19.8 (14.1-24.1)	7.4 (4.0-20.0)	4.5 (2.5-10.0)	7.0 (3.0-13.0)	6.6 (3.5-13.0)	6.4 (2.5-16.0)
		F (83)	19.8 (12.4-23.7)	9.9 (5.0-21.0)	5.8 (2.5-11.8)	9.6 (3.8-30.0)	9.5 (3.2-28.0)	13.5 (3.0-24.0)
6.	16 - 19	M (58)	21.8 (18.2-26.5)	8.6 (4.8-18.4)	4.8 (2.4-9.0)	8.9 (4.0-20.0)	9.8 (4.6-25.4)	8.8 (2.8-24.2)
		F (65)	21.0 (13.5-29.5)	15.0 (8.8-33.9)	7.8 (4.0-16.0)	15.0 (8.0-28.0)	17.2 (8.2-32.9)	15.3 (8.0-32.0)
7.	20 - 39	M (190)	20.6 (17.4-26.5)	9.4 (2.8-27.0)	5.9 (2.0-20.0)	12.2 (5.6-38.8)	12.63 (4.0-40.0)	9.9 (4.0-38.2)
		F (198)	19.6 (16.5-26.0)	15.8 (4.4-37.0)	7.3 (2.5-32.9)	17.2 (5.4-40.0)	18.3 (5.2-43.0)	14.6 (4.0-42.0)
8.	40 - 59	M (83)	21.8 (17.0-29.8)	13.2 (4.0-28.0)	7.5 (2.0-21.2)	16.8 (3.2-40.0)	17.3 (4.2-40.0)	13.8 (3.6-43.0)
		F (60)	19.8 (16.0-25.0)	16.0 (5.1-34.0)	7.9 (2.0-29.0)	18.6 (7.0-40.0)	19.1 (7.0-47.8)	16.5 (4.0-39.0)
9.	> 60	M (18)	22.1 (16.5-24.0)	9.5 (3.0-18.1)	5.8 (2.0-12.0)	14.5 (6.4-36.2)	14.1 (4.4-39.2)	9.9 (2.3-20.6)
		F (20)	21.0 (17.8-23.8)	15.7 (3.2-31.0)	7.5 (2.0-15.2)	13.1 (4.8-30.4)	18.7 (4.2-30.2)	15.6 (5.4-30.4)

TABLE II. WEIGHT AND DIMENSION OF BRAIN STEM

Age (years)	Male				Female			
	n	Body height (cm)	Body weight (kg)	Brain stem (g)	n	Body height (cm)	Body weight (kg)	Brain stem (g)
10-12	4	140 ± 12	22 5 ± 2 1	27 8 ± 8 1	1	125	25 0	15 1
13-15	3	148 ± 17	46 7 ± 26 6	17 8 ± 3 2		NA	NA	NA
16-19	9	159 ± 9 8	60 8 ± 8 2	35 1 ± 12 1	3	165 ± 7 5	53 0 ± 16 1	25 9 ± 4 8
20-39	80	162 ± 6 0	55 2 ± 7 6	32 2 ± 11 4	27	155 ± 5 9	48 4 ± 7 1	27 7 ± 9 8
40-59	21	161 ± 6 2	56 6 ± 10 6	34 6 ± 15 0	3	149 ± 8 0	53 0 ± 9 9	36 0 ± 3 2
60-72	5	157 ± 11 8	50 0 ± 12 8	56 7 ± 26 3	1	148	45 0	18 0

TABLE III. WEIGHT AND DIMENSION OF CEREBRUM

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	2	1220 ± 178	18 5 ± 0 7	15 5 ± 2 1	7 75 ± 0 35	1	1191	18 2	14 3	7 00
13-15	2	1187 ± 35	19 8 ± 1 8	15 4 ± 3 8	7 00 ± 0 71		NA	NA	NA	NA
16-19	8	1163 ± 129	18 9 ± 1 9	14 6 ± 1 2	6 75 ± 0 77	3	1196 ± 42	19 2 ± 1 6	14 4 ± 1 4	9 0 ± 3 1
20-39	70	1176 ± 119	18 5 ± 1 9	14 6 ± 1 6	7 25 ± 2 11	23	1048 ± 138	18 0 ± 1 4	13 6 ± 1 1	6 6 ± 0 6
40-59	19	1190 ± 122	18 9 ± 1 6	14 6 ± 1 4	6 95 ± 1 34	2	1073 ± 239	18 8 ± 1 8	15 2 ± 3 9	6 6 ± 1 3
60-72	5	1137 ± 56	18 4 ± 0 8	13 9 ± 0 2	7 20 ± 0 57	1	1122	20 0	16 0	4 50

TABLE IV. WEIGHT AND DIMENSION OF CEREBELLUM

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	2	140 ± 2	12 5 ± 0 7	6 50 ± 0 7	3 50 ± 0	1	142	11 6	6 4	2 8
13-15	2	151 ± 30	12 0 ± 1 4	6 20 ± 1 1	2 25 ± 1 1		NA	NA	NA	NA
16-19	8	138 ± 22	11 1 ± 1 0	6 29 ± 1 4	3 00 ± 0 8	3	132 ± 11	11 2 ± 1 2	6 30 ± 0 61	3 7 ± 0 3
20-39	70	137 ± 17	11 4 ± 1 1	5 89 ± 0 9	3 15 ± 0 7	23	127 ± 13	11 1 ± 1 0	6 03 ± 0 75	3 1 ± 0 5
40-59	19	144 ± 17	11 2 ± 1 4	6 04 ± 1 2	3 06 ± 0 6	2	132 ± 7	11 2 ± 1 1	6 05 ± 0 92	3 2 ± 0 4
60-72	5	136 ± 10 2	10 6 ± 1 1	5 68 ± 0 3	3 28 ± 0 6	1	119	9 5	6 0	3 02

TABLE V. WEIGHT AND DIMENSION OF SALIVARY GLAND

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	4	42 9 ± 17 7	11 1 ± 3 4	4 33 ± 0 31	1 20 ± 0 20	1	36 5	13 50	4 2	1 5
13-15	3	69 3 ± 25 4	15 1 ± 1 8	5 20 ± 2 89	1 50 ± 0 87		NA	NA	NA	NA
16-19	8	90 7 ± 27 5	17 9 ± 4 0	4 76 ± 1 25	1 63 ± 0 64	3	93 ± 36	22 7 ± 3 2	5 0 ± 0 9	1 3 ± 0 3
20-39	77	78 4 ± 14 9	20 2 ± 2 9	4 56 ± 0 82	1 53 ± 0 49	27	65 8 ± 13 6	19 4 ± 2 0	4 6 ± 1 2	1 4 ± 0 4
40-59	21	92 7 ± 33 1	22 6 ± 3 5	4 83 ± 0 98	2 06 ± 1 29	3	70 2 ± 46 3	17 7 ± 3 6	3 8 ± 1 2	1 3 ± 0 4
60-72	5	70 1 ± 15 6	19 1 ± 2 1	4 48 ± 1 36	1 00 ± 0 41	1	81	22 5	5 5	1 5

TABLE VI. WEIGHT AND DIMENSION OF THYROID

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	4	6 6 ± 3 7	4 4 ± 1 6	1 8 ± 0 4	0 7 ± 0 5	1	15 0	4 40	1 9	1 5
13-15	3	11 7 ± 5 5	4 0 ± 1 3	2 5 ± 1 7	1 2 ± 0 4		NA	NA	NA	NA
16-19	9	14 0 ± 4 6	4 9 ± 0 7	3 7 ± 1 0	1 3 ± 0 6	3	23 7 ± 12 4	4 5 ± 0 4	4 3 ± 0 8	1 6 ± 0 8
20-39	78	16 8 ± 6 8	4 8 ± 0 1	3 1 ± 1 3	1 4 ± 0 8	27	17 8 ± 6 2	4 4 ± 0 7	2 8 ± 1 1	1 5 ± 0 6
40-59	21	19 6 ± 7 8	5 1 ± 1 2	3 0 ± 1 1	1 7 ± 1 0	3	14 5 ± 5 8	7 3 ± 3 2	4 4 ± 2 5	1 5 ± 0 4
60-72	4	14 8 ± 3 3	4 5 ± 0 6	3 5 ± 1 3	1 8 ± 0 2	1	40 5	6 00	3 6	1 8

TABLE VII. WEIGHT AND DIMENSION OF HEART

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	4	120 ± 36	9 4 ± 2 4	7 5 ± 1 5	3 9 ± 0 2	1	98 5	6 6	5 8	4 5
13-15	3	208 ± 80	10 3 ± 1 9	8 9 ± 2 9	4 9 ± 0 5		NA	NA	NA	NA
16-19	9	235 ± 28	12 1 ± 2 8	9 2 ± 1 6	4 4 ± 0 6	3	224 ± 90	11 2 ± 1 8	9 3 ± 1 8	4 4 ± 1 2
20-39	80	254 ± 36	11 8 ± 2 9	9 8 ± 1 9	4 4 ± 1 6	27	217 ± 35	12 1 ± 2 8	10 0 ± 2 3	4 2 ± 1 1
40-59	21	282 ± 51	12 5 ± 2 5	10 0 ± 1 5	4 4 ± 0 9	3	292 ± 60	12 0 ± 2 3	10 8 ± 2 1	4 6 ± 0 5
60-72	4	315 ± 49	11 5 ± 1 3	9 6 ± 2 0	4 2 ± 0 9	1	340	12 5	11 5	5 0

TABLE VIII. WEIGHT AND DIMENSION OF LUNG

Age (years)		Male					Female				
		n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	Right	4	163 ± 69	15 80 ± 1 3	11 8 ± 0 8	5 1 ± 1 6	1	164	15 6	10 0	3 6
	Left	4	147 ± 45	15 3 ± 1 5	12 3 ± 2 5	5 0 ± 1 0	1	135	15 0	13 2	3 7
13-15	Right	2	431 ± 99	20 5 ± 0 7	14 5 ± 0 7	9 2 ± 3 2		NA	NA	NA	NA
	Left	2	324 ± 64	20 5 ± 0 7	14 8 ± 4 6	7 5 ± 2 1		NA	NA	NA	NA
16-19	Right	8	395 ± 98	22 4 ± 2 1	13 4 ± 2 6	6 0 ± 1 0	3	358 ± 183	19 9 ± 3 7	14 7 ± 1 5	8 5 ± 0 9
	Left	7	361 ± 103	21 3 ± 2 3	13 4 ± 2 6	5 5 ± 1 2	3	295 ± 132	18 2 ± 2 5	14 6 ± 2 7	6 7 ± 1 9
20-39	Right	79	437 ± 178	22 6 ± 2 2	15 5 ± 2 8	7 3 ± 6 0	25	399 ± 138	21 5 ± 2 5	15 0 ± 2 7	7 3 ± 2 6
	Left	75	390 ± 125	21 5 ± 2 4	14 9 ± 3 0	6 1 ± 2 4	25	341 ± 110	20 1 ± 2 3	14 3 ± 3 0	6 3 ± 2 5
40-59	Right	19	422 ± 140	23 6 ± 2 6	16 0 ± 2 5	7 1 ± 2 9	3	487 ± 362	24 8 ± 3 2	15 2 ± 0 3	8 7 ± 3 8
	Left	18	364 ± 126	22 4 ± 2 8	15 2 ± 2 6	6 1 ± 2 7	3	341 ± 104	20 8 ± 1 4	14 5 ± 1 5	7 2 ± 3 4
60-72	Right	4	517 ± 207	25 3 ± 0 6	16 9 ± 2 8	3 2 ± 1 3	1	387	26 0	14 0	6 0
	Left	4	398 ± 109	25 8 ± 1 8	17 5 ± 0 7	4 2 ± 0 4	1	276	25 0	13 0	5 0

TABLE IX. WEIGHT AND DIMENSION OF TESTIS

Age (years)	Right Testis					Left Testis				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	2	6 50 ± 6 4	3 3 ± 1 0	1 9 ± 0 8	1 2 ± 0 6	2	6 75 ± 6 7	2 8 ± 0 3	1 9 ± 0 8	1 2 ± 0 6
13-15	3	11 8 ± 6 9	4 1 ± 1 6	2 5 ± 0 6	1 7 ± 1 2	3	11 8 ± 6 9	3 2 ± 0 3	2 5 ± 0 6	1 7 ± 1 1
16-19	9	13 9 ± 4 1	3 8 ± 0 8	2 5 ± 0 4	1 4 ± 0 4	9	13 7 ± 4 3	3 7 ± 0 6	2 4 ± 0 4	1 6 ± 0 5
20-39	74	13 3 ± 3 5	4 0 ± 1 0	2 6 ± 0 6	1 5 ± 0 4	74	13 1 ± 3 4	3 9 ± 0 9	2 6 ± 0 6	1 5 ± 0 4
40-59	20	14 2 ± 4 4	4 2 ± 1 5	2 8 ± 1 1	1 6 ± 0 9	20	13 4 ± 3 9	4 1 ± 1 3	2 7 ± 1 1	1 6 ± 1 0
60-72	3	16 9 ± 2 7	4 4 ± 0 4	2 1 ± 0 6	1 3 ± 0 5	3	15 8 ± 3 6	4 3 ± 0 4	2 7 ± 0 0	1 2 ± 0 4

TABLE X. WEIGHT AND DIMENSION OF LIVER

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	4	666 ± 57	25 3 ± 2 5	15 0 ± 2 3	5 5 ± 1 3		NA	NA	NA	NA
13-15	3	874 ± 187	25 3 ± 1 2	14 9 ± 2 2	4 6 ± 0 5		NA	NA	NA	NA
16-19	9	1110 ± 190	28 7 ± 2 9	16 0 ± 2 2	5 7 ± 1 1	3	1100 ± 295	29 7 ± 4 2	15 0 ± 1 0	6 8 ± 1 6
20-39	76	1120 ± 298	27 5 ± 3 3	16 6 ± 3 1	5 8 ± 1 4	27	1120 ± 237	28 7 ± 3 2	17 2 ± 3 1	5 4 ± 1 4
40-59	20	1130 ± 279	28 5 ± 5 7	17 0 ± 2 4	5 9 ± 1 5	3	919 ± 152	26 8 ± 5 5	16 8 ± 1 3	5 0 ± 1 0
60-72	5	1060 ± 246	28 8 ± 1 9	16 2 ± 2 1	5 3 ± 1 0	1	945	28 0	17 0	6 0

TABLE XI. WEIGHT AND DIMENSION OF SPLEEN

Age (years)	Male					Female				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	4	73 1 ± 17 4	10 0 ± 0 9	5 9 ± 0 8	1 8 ± 0 7	1	70 0	12 1	5 7	1 5
13-15	2	83 8 ± 37 1	12 0 ± 1 4	6 8 ± 2 5	1 8 ± 0 4		NA	NA	NA	NA
16-19	9	177 ± 86	13 2 ± 2 6	8 0 ± 1 4	2 1 ± 0 9	3	109 ± 81 8	13 7 ± 2 1	7 2 ± 2 0	2 3 ± 0 3
20-39	76	113 ± 57	11 4 ± 1 6	7 1 ± 1 2	2 2 ± 0 9	27	104 ± 28 3	11 9 ± 1 7	6 9 ± 1 2	2 2 ± 0 7
40-59	21	117 ± 50	12 0 ± 2 1	7 4 ± 1 8	2 1 ± 0 6	2	59 0 ± 12 1	10 3 ± 0 4	6 6 ± 0 9	1 6 ± 1 3
60-72	4	75 8 ± 32 0	10 2 ± 2 4	7 9 ± 1 2	2 5 ± 0 9	1	73 0	13 0	6 5	2 1

TABLE XII. WEIGHT AND DIMENSION OF PROSTATE AND UTERUS

Age (years)	Prostate					Uterus				
	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	2	9 75 ± 4 6	3 0 ± 1 1	2 4 ± 0 8	1 0 ± 0 1	1	NA	3 5	3 3	0 6
13-15	2	17 0 ± 4 2	5 0 ± 1 4	3 4 ± 0 6	1 7 ± 0 3		NA	NA	NA	NA
16-19	9	19 5 ± 4 4	4 1 ± 0 8	2 7 ± 0 5	1 7 ± 0 4	2	40 5 ± 0 0	7 5 ± 0 7	5 0 ± 0 0	2 5 ± 0 0
20-39	73	19 1 ± 10 9	4 5 ± 1 1	3 3 ± 0 9	1 9 ± 0 6	25	58 5 ± 29 8	8 0 ± 2 2	5 6 ± 1 3	2 8 ± 0 5
40-59	17	18 9 ± 3 0	4 5 ± 1 0	3 6 ± 0 6	1 7 ± 0 6	2	97 4 ± 80 0	6 4 ± 1 9	6 0 ± 2 1	3 4 ± 1 5
60-72	3	20 0 ± 2 0	5 4 ± 0 9	3 6 ± 0 5	1 9 ± 0 5		NA	NA	NA	NA

TABLE XIII. WEIGHT AND DIMENSION OF KIDNEY

Age (years)	Male						Female				
		n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	Right	4	56 2 ± 13 1	8 53 ± 1 5	4 8 ± 0 7	2 4 ± 0 1	1	48 5	8 7	4 4	2 2
	Left	3	58 6 ± 12 0	8 67 ± 0 8	4 9 ± 0 8	2 5 ± 0 0	1	53 4	8 2	4 2	2 4
13-15	Right	3	96 0 ± 30 1	9 83 ± 1 9	5 0 ± 2 2	2 6 ± 0 5		NA	NA	NA	NA
	Left	3	98 3 ± 26 1	9 63 ± 1 3	4 5 ± 1 5	2 5 ± 0 5		NA	NA	NA	NA
16-19	Right	9	106 ± 15 3	11.0 ± 1 4	5 8 ± 0 5	2 5 ± 0 4	3	105 ± 18.12	10 7 ± 0 6	6 0 ± 0 5	2 9 ± 0 2
	Left	9	100 ± 14 9	9 81 ± 1 0	5 3 ± 0 6	2 3 ± 0 5	3	99 2 ± 4 80	10 7 ± 0 3	6 3 ± 1 2	2 2 ± 0 4
20-39	Right	79	102 ± 21 1	9 94 ± 1 6	5 4 ± 1 0	2 5 ± 0 6	27	96 0 ± 24 49	12 4 ± 18 2	5 1 ± 1 0	5 1 ± 1 5
	Left	79	105 ± 21 7	9 90 ± 2 0	5 2 ± 1 0	2 7 ± 2 0	27	96 0 ± 22 14	9 8 ± 2 2	5 1 ± 1 0	5 5 ± 0 5
40-59	Right	19	109 ± 19 6	10 7 ± 1 3	5 6 ± 0 7	2 5 ± 0 6	2	90 0 ± 26 87	10 0 ± 0 8	5 3 ± 0 3	3 0 ± 0 9
	Left	20	110 ± 25 1	10 8 ± 1 4	5 4 ± 1 1	2 6 ± 0 8	3	71 9 ± 14 33	10 0 ± 0 5	5 5 ± 0 5	2 7 ± 0 2
60-72	Right	5	88 3 ± 9 1	10 5 ± 1 7	5 2 ± 1 0	1 8 ± 0 2	1	80 5	12 0	5 5	2 5
	Left	5	91 1 ± 10 2	10 0 ± 2 2	5 2 ± 0 5	2 2 ± 0 2	1	85 5	11 0	5 5	2 5

TABLE XIV. WEIGHT AND DIMENSION OF ADRENAL

Age (years)	Male						Female				
		n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	n	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
10-12	Right	4	2 88 ± 0 48	4 27 ± 0 64	2 80 ± 0 20	0 30 ± 0 10	1	3 00 ± 0 00	4 70 ± 0 00	3 20 ± 0 00	0 30 ± 0 00
	Left	4	2 50 ± 0 41	4 53 ± 0 61	2 40 ± 0 79	0 33 ± 0 15	1	2 00 ± 0 00	5 20 ± 0 00	1 70 ± 0 00	0 30 ± 0 00
13-15	Right	3	4 33 ± 0 58	4 33 ± 1 15	2 47 ± 0 46	0 40 ± 0 00		NA	NA	NA	NA
	Left	3	4 17 ± 0 76	4 47 ± 1 60	2 33 ± 0 28	0 37 ± 0 06		NA	NA	NA	NA
16-19	Right	9	5 43 ± 2 18	5 50 ± 1 08	3 00 ± 0 66	0 40 ± 0 19	3	6 00 ± 1 76	5 33 ± 0 58	3 33 ± 0 58	0 37 ± 0 21
	Left	9	5 22 ± 2 11	5 28 ± 0 83	2 79 ± 0 90	0 42 ± 0 13	3	5 63 ± 1 52	5 83 ± 1 04	3 17 ± 1 15	0 47 ± 0 21
20-39	Right	77	5 71 ± 1 88	5 09 ± 0 74	2 95 ± 0 68	0 41 ± 0 18	27	4 84 ± 1 53	4 81 ± 0 96	2 90 ± 0 90	0 56 ± 0 61
	Left	77	5 59 ± 1 82	5 14 ± 0 99	2 73 ± 0 84	0 42 ± 0 19	27	4 83 ± 1 69	4 85 ± 0 91	2 71 ± 0 86	0 47 ± 0 22
40-59	Right	21	6 78 ± 2 84	5 40 ± 1 19	3 15 ± 0 73	0 41 ± 0 10	3	3 57 ± 1 40	4 70 ± 1 59	2 77 ± 0 31	0 30 ± 0 00
	Left	21	6 59 ± 2 75	5 08 ± 1 06	2 73 ± 0 79	0 41 ± 0 13	2	2 20 ± 1 70	3 85 ± 2 19	2 10 ± 1 13	0 30 ± 0 00
60-72	Right	5	5 76 ± 2 38	4 90 ± 0 58	3 30 ± 0 24	0 43 ± 0 10	1	5 50 ± 0 00	5 00 ± 0 00	3 50 ± 0 00	0 60 ± 0 00
	Left	5	5 34 ± 2 45	4 93 ± 0 43	2 98 ± 0 46	0 45 ± 0 06	1	4 00 ± 0 00	4 00 ± 0 00	3 01 ± 0 00	0 50 ± 0 00

TABLE XV. ELEMENTAL CONTENT OF INTERNAL ORGANS

Organs/tissues	n	Na (mg/g)		K (mg/g)		Ca (mg/g)		Mg (mg/g)	
		range	average ± SD	range	average ± SD	range	average ± SD	range	average ± SD
Heart	20	0 93 - 1 56	1 22 ± 0 22	0 24 - 2 25	1 57 ± 0 63	0 001 - 0 070	0 022 ± 0 021	0 03 - 0 16	0 10 ± 0 05
Cerebrum	20	0 12 - 2 73	1 49 ± 0 73	1 28 - 3 70	2 56 ± 0 77	0 001 - 0 040	0 021 ± 0 014	0 01 - 0 15	0 08 ± 0 05
Liver	18	0 09 - 2 00	1 19 ± 0 53	1 25 - 2 93	1 93 ± 0 59	0 001 - 0 677	0 119 ± 0 229	0 02 - 0 24	0 13 ± 0 07
Lung	20	0 14 - 2 93	1 81 ± 0 77	0 74 - 2 15	1 38 ± 0 44	0 004 - 0 064	0 029 ± 0 023	0 02 - 0 17	0 07 ± 0 05
Muscle	20	0 05 - 1 52	0 80 ± 0 41	1 26 - 3 61	2 72 ± 0 75	0 001 - 0 030	0 013 ± 0 008	0 02 - 0 23	0 13 ± 0 08
Rib bone	20	0 21 - 4 00	2 29 ± 1 32	0 29 - 6 89	1 92 ± 1 95	0 944 - 40 8	13 6 ± 12 0	0 07 - 0 79	0 34 ± 0 25
Bladder	20	0 60 - 2 15	1 24 ± 0 60	0 34 - 1 05	0 68 ± 0 31	0 005 - 1 37	0 231 ± 0 441	0 03 - 1 55	0 26 ± 0 49
Testis	20	0 16 - 4 08	2 01 ± 1 02	0 88 - 1 74	1 47 ± 0 29	0 003 - 0 092	0 041 ± 0 034	0 03 - 0 80	0 14 ± 0 25
Spleen	20	0 13 - 3 27	1 33 ± 0 87	1 66 - 3 66	2 49 ± 0 67	0 002 - 0 309	0 057 ± 0 097	0 04 - 0 16	0 09 ± 0 04

TABLE XV. (CONTINUED)

Organs/tissues	n	Mn (μg/g)		Fe (μg/g)		Cu (μg/g)		Zn (μg/g)	
		range	average ± SD	range	average ± SD	range	average ± SD	range	average ± SD
Heart	20	0 21 - 0 67	0 43 ± 0 17	34 8 - 89 0	46 8 ± 16 9	0 11 - 4 27	2 28 ± 1 12	13 2 - 91 4	23 8 ± 25 4
Cerebrum	20	0 28 - 0 59	0 41 ± 0 12	28 6 - 97 9	51 5 ± 27 8	0 23 - 5 18	2 75 ± 1 71	8 57 - 15 5	10 9 ± 2 33
Liver	18	0 86 - 1 90	1 33 ± 0 35	20 8 - 374	113 ± 115	0 36 - 24 7	12 2 ± 7 93	19 4 - 73 2	50 9 ± 16 6
Lung	20	0 27 - 0 61	0 42 ± 0 12	46 6 - 200	115 ± 46 4	0 04 - 5 48	1 24 ± 1 64	6 31 - 19 1	11 0 ± 3 48
Muscle	20	0 06 - 0 99	0 36 ± 0 30	19 4 - 115	45 6 ± 28 9	0 16 - 3 10	1 04 ± 0 84	18 0 - 57 6	43 4 ± 14 8
Rib bone	20	0 32 - 3 55	1 03 ± 0 98	6 81 - 89 8	49 6 ± 28 0	0 17 - 1 93	1 10 ± 0 61	4 34 - 56 6	27 7 ± 15 6
Bladder	20	0 21 - 1 59	0 84 ± 0 55	8 29 - 73 8	34 8 ± 24 5	0 09 - 18 8	3 24 ± 5 89	6 83 - 32 9	14 5 ± 7 78
Testis	20	0 11 - 0 67	0 31 ± 0 18	8 02 - 50 6	22 7 ± 13 5	0 14 - 1 23	0 79 ± 0 33	7 52 - 10 8	8 43 ± 1 11
Spleen	20	0 14 - 0 55	0 38 ± 0 13	35 4 - 245	155 ± 71 8	0 09 - 1 66	0 91 ± 0 59	9 19 - 21 3	14 5 ± 3 24

TABLE XVI. CONTENT OF ELEMENTS IN SELECTED FOODSTUFFS

Foodstuff	n	Na (mg/g)	K (mg/g)	Ca (mg/g)	Mg (mg/g)	Fe (mg/g)	Zn (mg/g)	Mn (mg/g)	Cu (mg/g)
Rice	26	0 17 ± 0 21	1 57 ± 2 36	0 09 ± 0 04	0 32 ± 0 21	5 05 ± 2 02	21 8 ± 16 2	6 45 ± 1 43	2 73 ± 1 16
Soybean	7	0 28 ± 0 25	23 6 ± 12 7	1 35 ± 0 96	1 57 ± 1 09	37 6 ± 27 1	20 6 ± 14 2	15 2 ± 10 9	5 23 ± 3 76
Spinach	7	1 95 ± 0 78	41 6 ± 29 3	10 7 ± 0 04	4 25 ± 2 95	30 9 ± 65 1	18 6 ± 25 4	49 6 ± 84 3	2 02 ± 2 49
Egg	7	7 66 ± 5 71	4 66 ± 1 71	1 69 ± 0 79	0 40 ± 0 09	57 5 ± 38 8	82 ± 102	0 97 ± 0 56	3 77 ± 4 19
Water spinach	7	6 58 ± 3 72	55 3 ± 40 0	3 92 ± 4 66	1 00 ± 1 13	65 2 ± 124	9 1 ± 12 1	29 4 ± 41 9	2 51 ± 2 83
Corn	13	0 13 ± 0 11	2 56 ± 1 75	0 09 ± 0 08	0 75 ± 0 59	11 9 ± 6 6	15 5 ± 9 7	3 47 ± 2 13	1 87 ± 1 15
Cabbage	7	1 02 ± 0 35	16 1 ± 10 9	4 36 ± 3 15	1 40 ± 0 70	11 4 ± 16 0	13 4 ± 12 4	31 0 ± 47 4	1 94 ± 1 39

TABLE XVII. AVERAGE DAILY FOOD CONSUMPTION (g/person/day) OF AGE GROUPS IN WEST INDONESIA (NORTH SUMATRA)

Food	Age (years)						
	1 - 3	4 - 6	7 - 9	10 - 12	20 - 39	40 - 59	> 60
Cereals & prod	393	26 0	119	90 0	510	366	305
Nuts & seed	NA	NA	NA	NA	NA	346	NA
Pulses	NA	100	NA	NA	410	NA	600
Potatoes & starches	225	174	300	NA	238	271	175
Sugar	NA	NA	NA	NA	54 6	156	45 7
Confectioneries	NA	NA	NA	NA	NA	NA	NA
Fats & oils	25 0	20 0	45 0	25 0	103	111	71 7
Fruits	150	NA	88 3	75 0	93 8	70 0	70 0
Vegetables	50 0	100	75 0	40 0	212	251	165
Fish	108	50 0	26 0	30 0	123	163	148
Meat	NA	NA	NA	NA	210	150	50 0
Eggs	NA	NA	NA	NA	66 8	60 0	75 0
Milk & products	NA	NA	NA	NA	49 2	17 1	25 0

TABLE XVIII AVERAGE DAILY FOOD CONSUMPTION (g/person/day) OF AGE GROUPS IN MIDDLE INDONESIA (JAKARTA)

Food	Age (years)							
	1 - 3	4 - 6	7 - 9	10 - 12	16 - 19	20 - 39	40 - 59	> 60
Cereals & prod	102	104	138	88 3	152	171	181	179
Nuts & seed	6 70	32 0	43 8	54 1	48 6	46 5	27 8	29 2
Pulses	33 2	32 4	77 5	22 4	59 3	66 5	90 4	109
Potatoes & starches	47 2	22 4	50 6	39 9	64 6	113	76 0	114
Sugar	36 6	37 8	32 6	25 8	37 0	35 7	39 2	17 6
Confectioneries	20 5	19 7	19 5	6 00	31 9	17 2	20 0	21 6
Fats & oils	20 9	9 00	21 2	16 5	30 6	29 3	37 4	24 0
Fruits	121	33 0	87 4	64 8	159	156	183	164
Vegetables	112	16 0	69 8	57 4	62 7	75 4	15 7	138
Fish	10 0	80 0	32 0	23 3	39 4	50 1	49 9	69 3
Meat	57 6	90 0	48 9	39 2	105	64 6	53 1	79 9
Eggs	73 3	NA	54 6	42 5	45 8	46 2	22 6	50 5
Milk & products	267	293	48 6	240	118	147	174	116

TABLE XIX AVERAGE DAILY FOOD CONSUMPTION (g/person/day) OF AGE GROUPS IN EAST INDONESIA (EAST NUSA TENGGARA)

Food	Age (years)								
	1 - 3	4 6	7 - 9	10 - 11	12 - 15	16 - 19	20 - 39	40 - 59	> 60
Cereals & prod	107	241	262	266	283	209	362	315	305
Nuts & seed	124	66 2	168	98 2	146	158	268	358	328
Pulses	210	210	254	73 1	130	26 3	362	77 2	87 6
Potatoes & starches	4 7	70 0	58 9	100	100	138	89 8	200	NA
Sugar	NA	NA	NA	NA	25 0	NA	20 2	NA	24 7
Confectioneries	40 0	41 9	75 0	24 7	20 0	NA	85 0	NA	NA
Fats & oils	NA	47 3	46 3	134	114	NA	98 2	98 8	81 0
Fruits	73 3	364	NA	146	210	188	361	411	NA
Vegetables	378	264	373	423	486	432	1106	79 0	NA
Fish	66 6	61 8	47 7	46 9	52 3	34 0	121	58 8	43 0
Meat	52 7	57 4	115	64 1	45 8	62 5	103	85 6	NA
Eggs	NA	36 0	NA	40 0	NA	NA	41 2	NA	NA
Milk & products	10 0	23 3	NA	NA	20 0	NA	15 00	NA	NA

TABLE XX. FAMILY CONSUMPTION FREQUENCY OF FOODSTUFF (%, n = 50, often = 1-3x/week, rare = 1-2x/month, very rare = 1x/month)

No	Food item	3x/day	2x/day	1x/day	often	rare	very rare	never	blank
1	Rice	60	40	-	-	-	-	-	-
2	Rice noodle	-	-	2	24	20	32	-	22
3	Glutinous rice	-	-	2	14	16	34	10	24
4	Bread	2	2	20	50	8	12	2	4
5	Wheat noodle	-	4	4	32	22	20	2	16
6	Potato	-	-	2	48	12	14	-	24
7	Sweet potato	-	-	2	22	32	28	2	14
8	Cassava	-	2	2	24	30	30	2	10
9	Taro, yam	-	-	-	4	10	40	22	24
10	Casava noodle	-	-	-	12	12	42	4	30
11	Sugar	6	44	30	4	-	4	-	12
12	Milk	2	12	22	26	4	8	20	6
13	Cheese	-	-	-	14	2	44	24	16
14	Eggs	-	4	18	64	8	2	2	2
15	Beef	-	2	4	56	20	12	-	6
16	Mutton	-	-	-	10	6	36	26	2
17	Pork	-	-	-	14	6	8	44	28
18	Chicken	2	2	4	66	12	6	-	4
19	Fish	-	6	8	52	16	6	6	6
20	Shrimp	-	-	-	28	14	34	12	12
21	Cuttle fish/squid	-	-	-	14	10	44	20	12
22	Crab	-	-	-	-	4	42	34	20
23	Shellfish	-	-	-	2	-	30	26	42
24	Soybean curd	6	18	18	48	2	4	-	4
25	Ferm soyb press cake	6	18	18	48	2	4	-	4
26	Oncom	-	-	4	22	12	30	14	18
27	Peanut	-	-	-	49	18	20	-	14
28	Green bean	4	4	2	54	14	20	-	2
29	Kidney bean	-	-	-	38	22	18	6	16
30	Bambara ground nut	-	-	-	2	18	34	16	30
31	Vegetables (green, yellow,	10	34	12	34	2	-	-	8
32	red)	2	14	-	44	18	8	4	10
33	Vegetables (white)	-	26	24	18	4	2	-	26
34	Fruit	-	-	-	-	2	12	14	72
35	Butter	-	-	2	10	14	10	6	58
36	Animal fat	-	-	10	42	12	14	4	18
37	Margarine	2	20	8	4	6	16	2	42
38	Vegetable oil	-	-	-	-	4	12	26	58
	Mayonnaise								

TABLE XXI. INDIVIDUAL CONSUMPTION FREQUENCY OF FOODSTUFF (%, n = 50, often = 1-3x/week, rare = 1-2x/month, very rare = 1x/month)

No	Food item	3x/day	2x/day	1x/day	often	rare	very rare	never	blank
1	Rice	68 3	28 0	3 66	-	-	-	-	-
2	Rice noodle	-	-	-	47 9	14 3	30 2	7 63	-
3	Glutinous rice	-	-	-	34 2	18 3	39 0	8 54	-
4	Bread	-	1 22	15 8	68 3	11 0	2 44	1 22	-
5	Wheat noodle	-	-	2 44	82 9	8 54	6 10	-	-
6	Potato	-	-	-	81 7	6 10	9 76	2 44	-
7	Sweet potato	-	-	-	26 8	26 8	37 8	8 54	-
8	Cassava	-	-	-	17 1	34 2	43 9	4 88	-
9	Taro, yam	-	1 22	-	1 22	7 32	56 1	34 2	-
10	Casava noodle	-	-	-	25 6	22 0	46 3	6 10	-
11	Sugar	15 8	28 0	35 4	15 8	2 44	2 44	-	-
12	Milk	2 44	7 32	36 6	28 0	4 88	7 32	13 4	-
13	Cheese	-	-	-	35 4	12 2	40 2	12 2	-
14	Eggs	-	1 22	20 7	72 0	3 66	1 22	1 22	-
15	Beef	-	3 66	2 44	87 8	3 66	1 44	-	-
16	Mutton	-	1 22	2 44	9 76	15 8	45 1	25 6	-
17	Pork	-	-	-	8 54	4 88	9 76	76 8	-
18	Chicken	-	-	8 54	86 6	1 22	2 44	1 22	-
19	Fish	-	1 22	6 10	75 6	9 76	4 88	2 44	-
20	Shrimp	-	-	1 22	47 6	20 7	18 3	12 2	-
21	Cuttle fish/squid	-	-	1 22	11 0	15 8	48 8	23 2	-
22	Crab	-	-	1 22	3 66	8 54	40 2	46 3	-
23	Shellfish	-	-	1 22	3 66	4 88	42 7	40 2	7 32
24	Soybean curd	2 44	4 88	7 32	75 6	1 22	1 22	1 22	6 10
25	Ferm soyb press cake	1 22	4 88	7 32	78 0	3 66	3 66	1 22	-
26	Oncom	-	-	1 22	6 10	9 76	36 6	46 3	-
27	Peanut	-	1 22	3 66	77 7	11 0	6 10	7 32	-
28	Green bean	-	-	1 22	43 9	23 1	30 5	1 22	-
29	Kidney bean	-	-	-	25 6	15 8	41 5	13 4	3 66
30	Bambara ground nut	-	-	-	3 66	7 32	54 9	30 5	3 66
31	Vegetables (green, yellow,	2 44	22 0	18 3	53 7	-	-	-	-
32	red)	1 22	2 44	12 2	73 2	3 66	4 88	-	2 44
33	Vegetables (white)	3 66	14 6	28 0	46 3	1 22	2 44	-	3 66
34	Fruit	-	-	-	7 32	3 66	11 0	7 32	70 7
35	Butter	-	-	1 22	22 0	9 76	28 0	25 6	13 4
36	Animal fat	1 22	1 22	12 2	61 0	9 76	6 10	4 88	3 66
37	Margarine	7 32	7 32	22 0	46 3	1 22	7 32	3 66	4 88
38	Vegetable oil	-	-	-	6 10	4 88	35 3	46 3	7 32
	Mayonnaise								

data were obtained only from Jakarta, North Sumatra and East Timor. Considering that the goal of the study is to establish the standard value for Indonesian people, more samples from other parts of Indonesia are essential. More data are still required to support the accuracy of the reported data.

The data of weights and dimensions of internal organs of Indonesian people were obtained from the people of Jakarta who died in accidents, due to homicide or suicide. These people are considered to be physically healthy and representative of normal individuals. The data are shown in Tables 2 to 14. The data cover only the age range from 10 to 72 years. Data for ages less than 10 is not available since autopsies on children are very rare. The number of sudden deaths of young people is relatively low and, if any, most parents do not allow an autopsy to be done. The number of samples of all age groups except the 20-39 years group is very small, so that most of the data for other age groups are not representative. The priority of this work was placed on acquiring data for males and females of ages 20-39 for comparison with the ICRP Reference Man adult data.

Weights of organs of males and females in this age group were compared. As shown in the Tables, the weight of most male organs was generally about 1% to 19% larger than those of females. However, the female thyroid was 5.6% larger than the males. Additionally, this work reports the distribution of several elements in selected internal organs/tissues taken from the forensic autopsies (Table 15).

The age specific food consumption observed in the three regions of Indonesia can be seen in Tables 16-18. The results were collected from a very few samples and are not representative due to certain difficulties and limited budget. The content of elements in the selected foodstuffs are also included in this report and presented in Table 19. Family and individual food patterns are pictured by the frequency of consumption of the various foodstuff expressed in percentage as shown in Tables 20 and 21. The data indicate that rice is consumed three times a day by most subjects. Milk and eggs are widely consumed and the intake tends to be higher in the younger age groups. Among the meat group, beef is the most popular and consumed with the highest frequency, followed by chicken both in popularity and quantity consumed. Vegetables, particularly the colored ones are used daily in high amounts.

The surveys were carried out during different seasons in the three different regions. In Jakarta and North Sumatra, the nutrition surveys were done in the wet season while in East Nusa Tenggara in the peak of the dry season. Even though there is a slightly different need in the food supply between the dry and wet seasons, and more surveys are essentially required to overcome these discrepancies. Beside the social cultural diversity among ethnic groups and tribes throughout Indonesia, the economic level of the people is not the same. The way of life and habits of Jakarta people from a middle class socio-economic level are different from those of North Sumatra from the same class, due to the difference in the progress of economic development. Also, manufactured foods are not usually consumed by the people in rural areas. It is certainly understood that people living in Jakarta (the capital city) with a fixed place to live are usually more prosperous than the same class of people living in more remote places in the country. Therefore, the present study is incomplete and more work is required to increase the number of samples and expand the observed areas.

CONCLUSION

The work presented in this report is far from being complete enough to properly characterize a Reference Indonesian Man which would, in turn, contribute to establishing Reference Man for Asia. However, the data on physical/anthropometric measurements on normal Indonesian people of both sexes and above 10 years was determined hopefully consistent with the principles of ICRP Reference Man revision. The normal values of the anthropometric parameters for younger people, and of the weights and dimensions of internal organs of various ages and both sexes need to be added. Also, much more time and effort is needed to get reliable information on daily food consumption of Indonesian people. Up to now, the number of samples and observed areas is neither sufficient nor representative of the population and area of Indonesia because of various problems including limited equipment and insufficient funding.

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PHYSICAL AND ANATOMICAL DATA, AND PART OF PHYSIOLOGICAL AND METABOLIC DATA FOR NORMAL JAPANESE WITH SPECIAL REFERENCE TO ESTABLISHING REFERENCE ASIAN MAN MODEL FOR THE ANATOMICAL CHARACTERISTICS

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Abstract

Studies on the physical, anatomical, and partial metabolic as well as physiological characteristics on Reference Japanese Man were undertaken to establish reference values for use in internal dose assessment and to assign annual limits on intakes of radionuclides for Japanese workers and members of the general public. Secular trends in, and/or probable influences of nutritional conditions on the organ mass were examined by comparing the present results with the other normal Japanese data.

The average height of male and female adults (20-50 y) were 168 and 155 cm, respectively. The body weights for males and females, 20-50 y, were - 64 and 52 kg. The data on the weight and size of twelve organs in normal males and eleven in normal females were obtained from autopsy, 12 to 24 h after sudden death.

The per caput intake of foodstuffs and principal nutrients were taken from the annual report of the National nutrition Survey for households in the urban and rural areas in all districts of Japan. Determination of elemental intake was made by collecting one full day of meals for adult males from 31 prefectures in practically all districts of Japan.

Pulmonary function parameters studied include total lung capacity, vital capacity, minute volume and 8h working volume at various levels of exertion - resting, light and heavy activity. The subjects were healthy, normal Japanese males and females.

Water balance data were obtained for 9 males and 6 females in Tokyo, under conditions of controlled energy and salt intake. The lengths of the study period were 6 and 10 days, respectively. Daily intakes of energy and salt were determined for the male student athletes for whom an indoor physical training was assigned.

INTRODUCTION

Studies on the physical, anatomical and part of metabolic as well as physiological characteristics on Reference Japanese Man were conceived in 1960s and initiated in early 1970s [1-5]. These were undertaken to establish reference values of the human body for use in internal dose assessment and to assign annual limits on intakes of radionuclides (i.e. the secondary limits set by the ICRP) for Japanese workers and members of the general public. Additional anatomical and physical data, as well as elemental intake information were added as the revision of Reference Man by ICRP Committee 2 began in 1986, and for the current IAEA-RCA Co-ordinated Research Programme which started in 1989 [6-11].

During the past five years, the studies were updated with an emphasis on developing a systematic model of the human body, based on the system used for ICRP Reference Man [1]. These studies were designed to establish Reference Japanese parameters for children and adults, and to contribute to a Reference Asian Man for internal dose assessment [8, 13]. Data on consumption of categorized foods, on the other hand, is needed to control radiation risks from contaminated foods and, more importantly, to predict pathways of radionuclides from foods to man. Analytical data on the intake of elements is significant in simulating the transfer of radionuclides through the ingestion, as well as in evaluating nutritional background of the population studied [2, 6, 7, 11]. The pulmonary function and water balance data will be also important to assess inhalation and ingestion exposures.

PHYSICAL MEASUREMENTS

Data on the measurements of Japanese physique were available in the School Health Survey that covers the entire country including children in the age range 5 to 17. This survey has been conducted since 1900 except for the period of World War 2 [14]. Approximately 72,000 subjects in kindergartens, 270,000 in primary schools, 220,000 in middle schools and 120,000 in high schools are sampled every year. Measurements are made in May for all students. The samples are few per cent of the population of these ages, and the total number of samples taken was approximately 7.78 millions during the period 1976 - 1988. Additional data were obtained for other ages from the National Nutrition Survey that includes measurement of physique, skinfold thickness and some health data. The survey is conducted in early November. Until recently, data were collected every five years. Now they are collected yearly [15]. Approximately 20,000 subjects from about 7,000 households in 300 *locations were studied for each year. Data on physical measurements for the newborn to 6.5* years are available in the report on the Growth of Infants and Preschool Children that is published every five years [16]. Body surfaces were estimated as described elsewhere [12].

MEASUREMENTS OF ORGAN MASS AND BODY COMPOSITION

The data on the weight and size of twelve organs in males and eleven in females were obtained from autopsy, 12 to 24 h after sudden death from traffic accidents, shocks, poisoning and heart attack. The subjects were believed to be otherwise normal and healthy at time of death. The autopsies were conducted in Tokyo Medical Examiners Office during the period 1971-1976 [2, 4]. From 10,598 cases, 2,880 were selected which showed no pathological changes in any organs [4]. In the period 1970-1980, a total number of 5,370 cases (including the previously studied 2,880 cases) with little or no pathological changes were selected from approximately 18,000 protocols in all [9, 13]. The data were statistically analyzed by using a CDC 6600 computer [2, 4]. These data were considered to represent normal individuals, appropriate for estimating organ mass in Reference Japanese Man.

Secular trend in, and/or probable influences of nutritional conditions on the organ mass were examined by comparing the present results with the other normal Japanese data reported by Aimi et al. [17]. These were obtained by methods identical to those used in the present work, in the same institute and for the similar purpose.

Mass of the mineralized bone were measured on 17 complete sets of bone samples [18]. Because the weight of red marrow reported for Japanese was considered to be relatively small, the mass of the red marrow was estimated using literature values for the distribution of marrow in an adult skeleton reported for a Caucasoid [19, 20].

The lipid content of the body was obtained from measurements of the skinfold thickness using Nagamine's equations for Japanese of different ages [12], then the lean body mass (LBM), contents of blood, water and muscle as well as protein. The "gross content" of ICRP Reference Man [1] were taken into consideration [13].

FOOD CONSUMPTION

The per caput intake of categorized foodstuffs and principal nutrients were taken from the annual report of the National nutrition Survey briefly mentioned above. In this survey, a stratified sampling is made for households of different occupation in the urban and rural areas in all districts of Japan [15].

Determination of elemental intake was made by obtaining the aliquots of ash samples from composite full one day meals collected from five households representing 5 adult males in every 31 locations throughout the country. In general, sampling was done in both summer

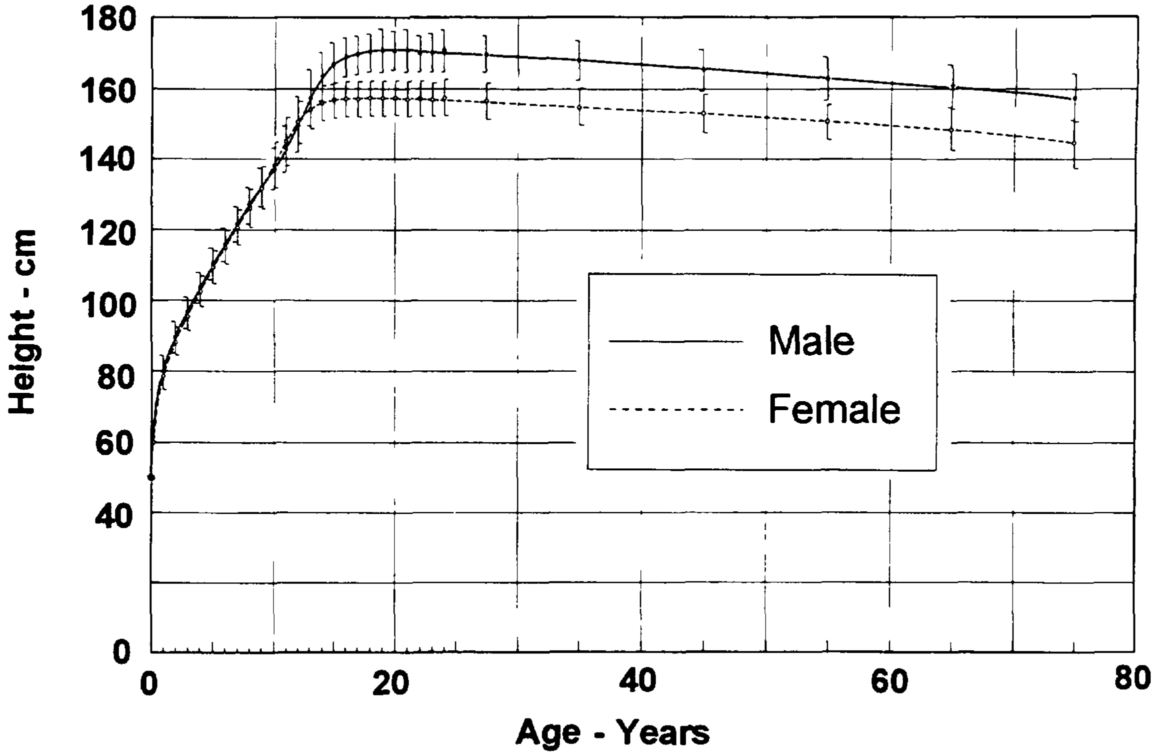


Fig 1 - Height as a function of age

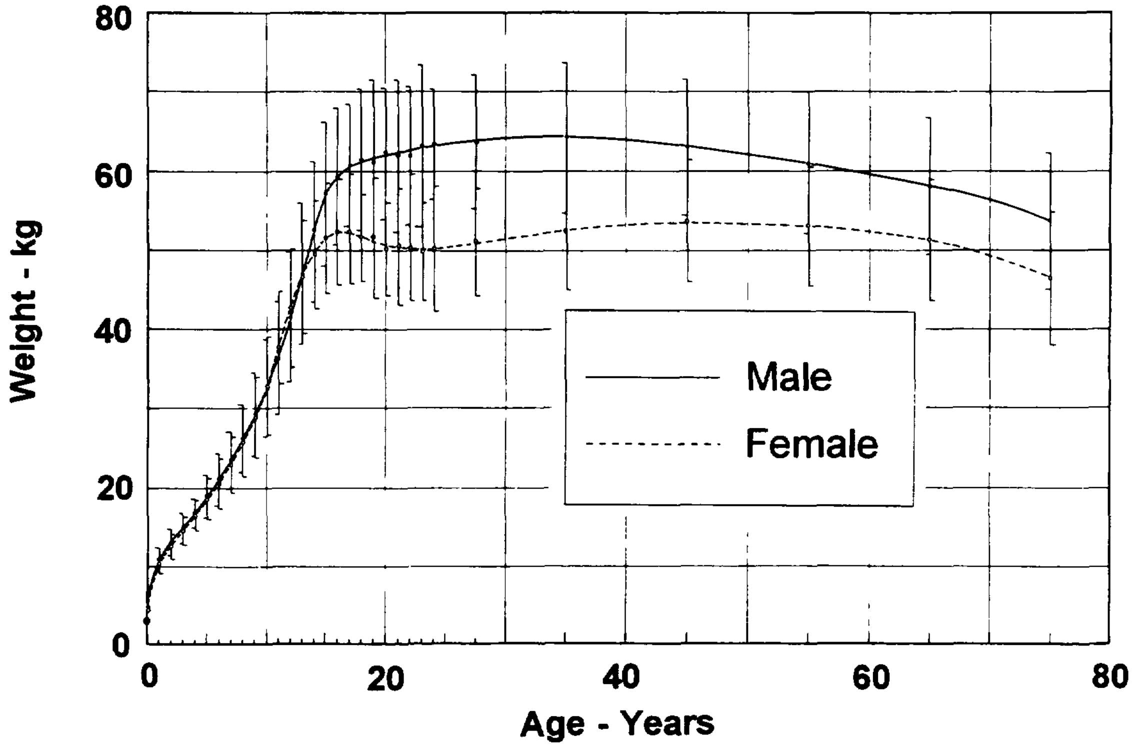


Fig 2 - Weight as a function of age

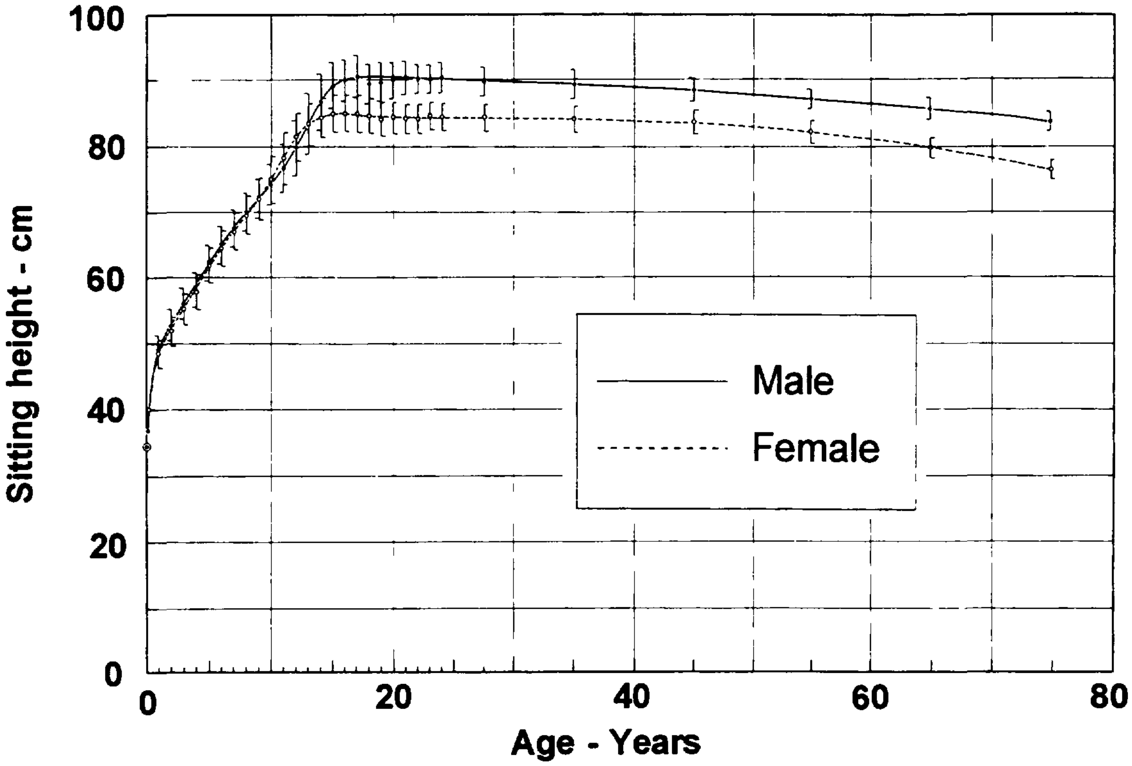


Fig 3 - Sitting height as a function of age

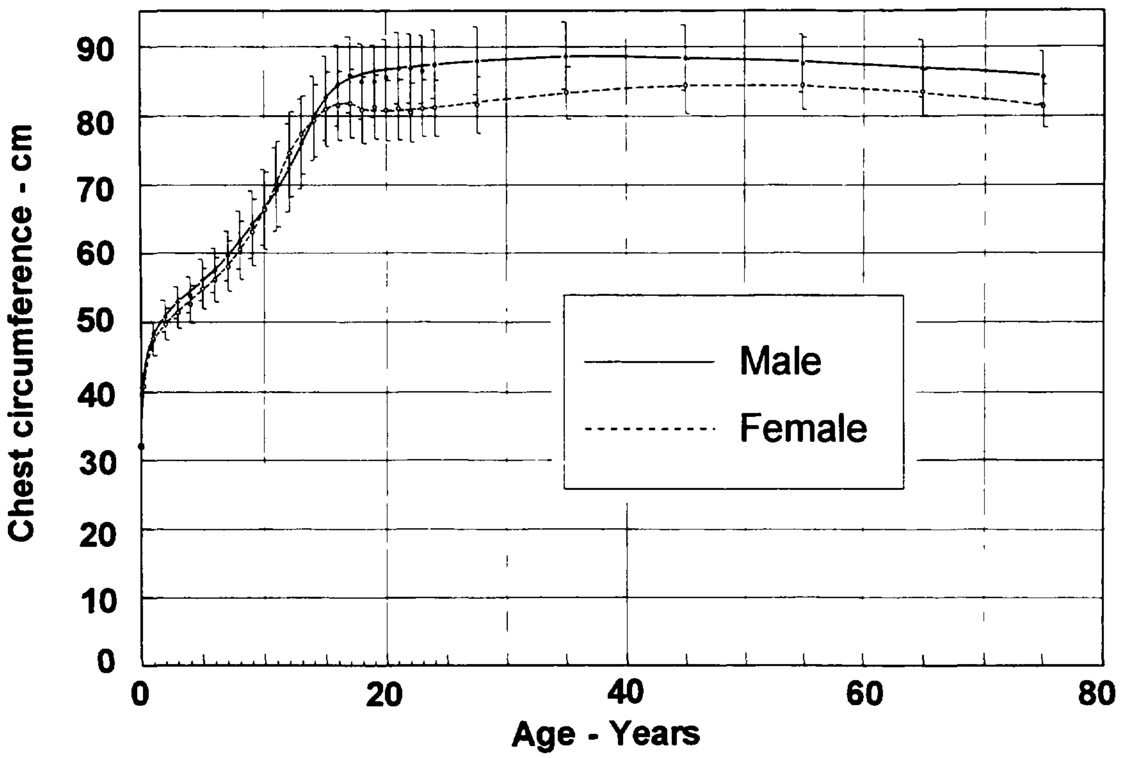


Fig 4 - Chest circumference as a function of age

TABLE I. INDIVIDUAL VALUES OF BODY HEIGHT, WEIGHT, SITTING HEIGHT AND CHEST CIRCUMFERENCE OF JAPANESE AS FUNCTIONS OF AGE

Sex	Age	Body height (cm)	Body weight (kg)	Sitting height (cm)	Chest circumference (cm)
Male	0-1 m	49.7	3.23	34.4	32.5
	2-3 m			36.8	
	1 y	75.3	9.64	(49.1)	46.9
	5 y	110.5	19.0	62.3	56.2
	10 y	137.4	32.5	74.3	66.8
	15 y	167.2	57.2	89.2	82.7
	20-29 y	170.2	63.3	90.1	87.4
	30-39 y	168.0	64.4	89.5	88.6
	40-49 y	165.2	63.2	88.7	88.3
	20-50 y	167.8	63.6	89.4	88.1
Female	0-1 m	49.3	3.16	34.4	32.4
	2-3 m			40.0	
	1 y	74.0	9.09	(48.4)	45.7
	5 y	109.6	18.6	61.9	54.9
	10 y	138.4	32.8	75.0	66.3
	15 y	156.7	51.6	85.0	81.0
	20-29 y	157.0	50.7	84.4	81.3
	30-39 y	155.0	52.5	84.2	83.3
	40-49 y	153.0	53.8	83.8	84.2
	20-50 y	155.0	52.3	84.1	82.9

and winter. The duplicate portion sampling method was used. Samples were dry ashed and stored until analysis. A clean-air chemical hood installed in a semi-clean laboratory was used. Analyses were made with extra grade purity mineral acids for further wet ashing to obtain clear sample solutions. These were analyzed for major, minor and trace elements by using ICP emission spectrometry (ICP-ES) as well as AAS [11]. For Th and U, ultrahigh purity acids were used and ^{232}Th and ^{238}U concentrations were determined using ICP mass spectrometry (ICP-MS) [21].

PULMONARY FUNCTION

Total lung capacity and vital capacity measurements were made with subjects selected from university personnel and students, and healthy local inhabitants of the Hiroshima Prefecture in the western part of main island of Honshu [22]. According to the co-ordinating respiratory physiologist, "no appropriate data are available for the newborn and (young) children because subjective strong effort is needed to obtain vital capacity and total lung capacity" [23]. The age groups presented here are partly different from those specified in the CRP protocol.

The subjects for the study of minute volume and 8h working volume were healthy, normal Japanese. Again, no appropriate data could be obtained for the newborn and 1-y old infants for the heavy activity level [24]. For the resting and light activity levels, ventilations were calculated from age-specific basal metabolic rates of Japanese (Workshop Committee for the Ministry of Health and Welfare 1984), assuming one liter of oxygen consumption per 4.80 kcal and using appropriate ventilatory equivalents (V. E.) for oxygen in different age groups and activity levels. Energy consumption of the light activity level is defined as twice that of the resting level. Therefore, no specific number of subjects was presented. Ventilations for the heavy activity level, on the other hand, were taken from the actual experiments [25, 26].

WATER BALANCE

Data on the daily intake of water and its elimination were obtained for 9 males (18-21 y) and 6 females (18-22 y) in Tokyo, under conditions of controlled energy and salt intake [27]. The lengths of the study period were 6 and 10 days, respectively. Daily intakes of energy and salt were 3000 kcal and 18 g per person for the male student athletes for whom an indoor *physical training was assigned. Daily intakes of energy and salt for the females were 1900* kcal and 6 g, respectively. They had a 1-h exercise regime using a bicycle ergometer to simulate commuting activities.

RESULTS AND DISCUSSION

Physical parameters

The body height, weight, sitting height and chest circumference of Japanese as functions of age are shown in Fig. 1-4 [12]. The individual values for the newborn to 40-49 y are shown in Table I. Secular trends, though less than a few decades ago, are still found. However, these measurements were averaged over for more than ten years. The secular trend in the sitting height was seen relatively small. As to the spurt in growth for boy and girls, reversals were seen in height (10-12 y), weight (11-12 y), sitting height (10-12 y) and chest circumference (10-13 y).

The distributions of these measurements were studied for 5 to 17 years during the period from 1980 to 1992. The frequency distribution for the body height, weight, sitting height and chest circumference for age 17 years are shown in Fig. 5 and 6. In Fig. 5, frequencies were plotted against logarithms of the body weight (kg). Sitting height and body height showed a normal distribution, while body weight and chest circumference have distributions that are skewed to higher values. However, the convention of using the population means was adopted for ease of comparison with other, published data. The average height of young male and female adults (20-29 y) was 170 and 157 cm, respectively while those of older adults (20-50 y) were 168 and 155 cm for males and females, respectively. The body weights for males and females of 20-29 y were 63.3 and 50.7 kg, respectively, similar to those of 20-50 y males and females - 63.6 and 52.3 kg, respectively. Reference values for the body height and weight were set as shown in Table II. The previous value of male height 165 cm [4] was increased to 170 cm because of the secular trend. In addition, a "two digit rule" was employed [1] considering the uncertainty due to biological variation. The height is close to that of ICRP Reference Man which is currently being reconsidered by the Task Group on Reference Man Revision.

Organ masses

The number of organ measurements for younger ages groups, i.e. newborn, 1, 5, 10 and 15 y were small: e.g. 70 male and 43 female subjects for a single age. The sampling among adults 20 to 50 y, however was sufficiently large: up to 2300 in males and about 550 in females. The individual variation was found to be particularly large for the thymus. To eliminate fluctuations, the observed values of organ masses at various ages were processed by a computer to obtain cubic spline approximation functions. Thus "smoothed" curves were obtained for each organ. However, from a cross sectional study, these will provide quantitative information on the growth of individual organs [12]. Masses of organs as functions of postnatal age are graphically presented elsewhere [12]. The "representative values" for 1, 5, 10, 15 y and the adult are listed in Table III.

The measured weights of bone at various sites, practically all bones of Japanese, are shown in Table IV, along with the mass of the wet mineralized bone and the estimated red marrow mass. The contents of the lipid, LBM, mineral, protein and water for various ages are presented in Table V.

Dietary measurements

The national averages and associated standard deviations are listed in Table VI for the food groups identified in the CRP format. A gradual decrease in consumption of rice was seen in the past 20 years. A slight but steady increase in the consumption of meat and dairy products have been observed. However, the typical pattern of food consumption as an Asian country seems to have been maintained. This was seen partly by elemental determinations of the duplicate meals as described later in this section.

The results of chemical analyses of dietary elemental composition are shown in Table VII. In spite of a large number of publications on elemental concentrations in foods, and several reported data on the intake of elements through the total diet, only a few like the present study cover practically the whole country. However, due to a short period of collecting samples, day-to-day variation plus the local and seasonal variation may be reflected in the reported ranges.

For natural iodine, an ordinary range of intake - 0.5-1.0, up to 2.0 mg/p/d - has been assumed according to the literature. It comes mainly from sea foods, especially algae in a raw and dried form, traditionally eaten as a component of the Japanese diet. These algae are mainly "konbu", tangle or kelp in Japanese (Laminaria) and "wakame" (Undaria). Due to considerable difficulties in determining iodine in whole one-day meals, representative daily intakes should be estimated from determination of natural iodine-rich marine algae and the data on their consumption.

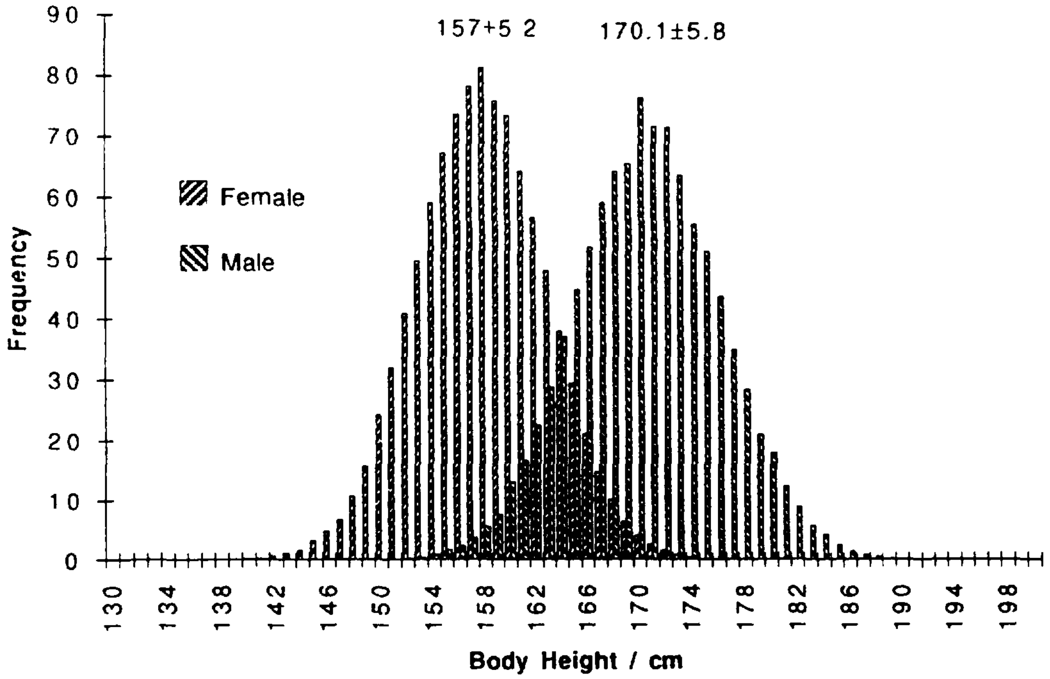
Similar stable intakes for various elements were observed in late 1960s and early 1980s, both by the duplicate portion study. The Sr-to-Ca ratio, which may reflect the pattern of food consumption or contribution of milk and dairy products in the intake of Sr and Ca, was seen essentially unchanged (Sr/Ca mass ratio found: 4.2×10^{-3} in 1967-69, 4.0×10^{-3} in 1981-82). Taking other data into consideration, tentative estimates of the elemental intake for Japanese studied by the duplicate portion method are presented in Table VIII.

Pulmonary function

As shown in Table IX, the total lung capacity was 5.24 and 5.58 l for the male of 16-19 and 20-29 y, respectively. That for the age range 20-49 y, the value was 5.59 l. The average total lung capacity was 4.05 l for the female adult, 20-49 y.

The vital capacity for the male and female, 16-79 y, was 3.89 ± 0.66 and 2.75 ± 0.46 l, respectively as shown in Table IX. It was 4.20 and 2.92 l for the 20-49 y male and female as calculated in the same table.

As shown in Table X, the minute volume for the newborn male and female was 1.6 and 3.2 l/min for the resting and light activity stage, respectively. Maximum values were seen for the age 15. In the male, it was 6.4, 12.6 and 102.9 l/min for the resting, light activity and



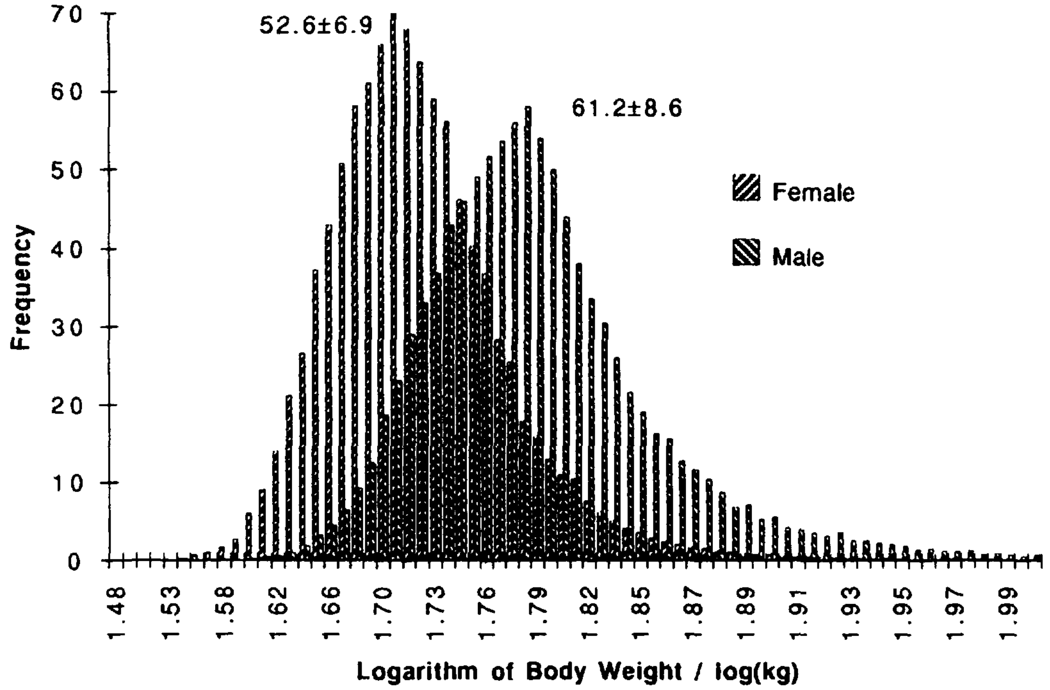
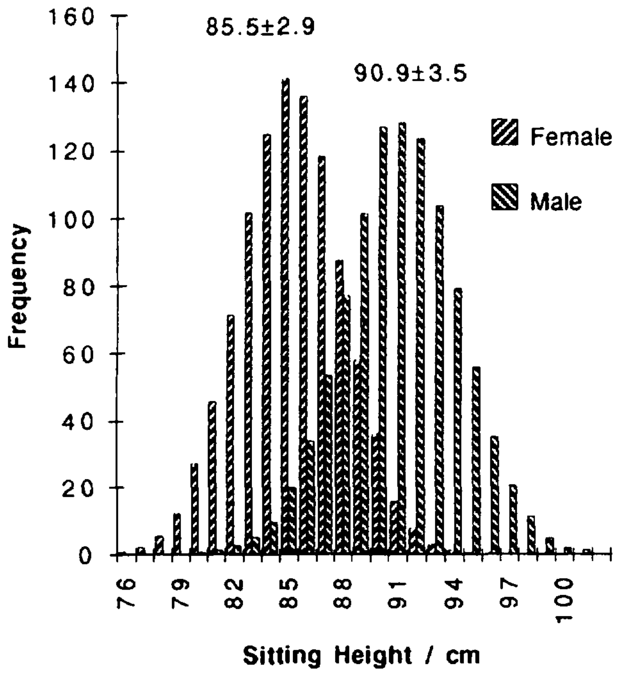


Fig. 5. Distribution of body height (upper) and weight (lower) for 17 year boys and girls found during 1980-92.



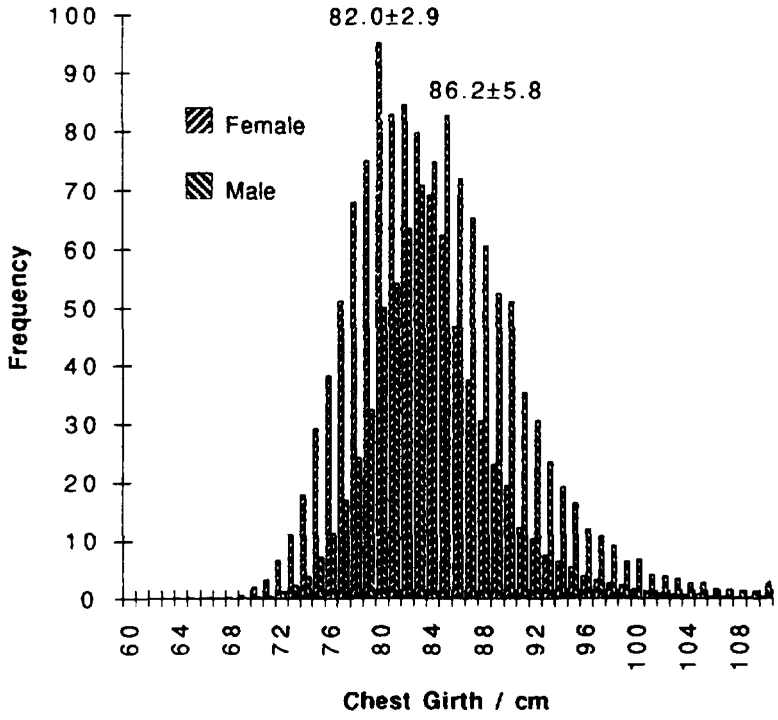


Fig. 6. Distribution of sitting height (upper) and chest circumference (lower) for 17 year boys and girls found during 1980-92.

heavy activity stage, respectively. In the 15-y female, the minute volume was 5.3, 10.6 and 57.4 l/min for the resting, light and heavy activity level, respectively. In the male adult, 20-50 y, it was 5.1, 10.2 and 87.0 l/min for the three stages, respectively in the increasing order. The minute volume for the female adult was 4.2, 8.4 and 52.5 l/min for the resting, and light and heavy activity level, respectively [25, 26].

The male and female newborn 8h working volume, in the resting stage was 768 l and under light activity was found to be 1536 l as shown in Table X. For the 15-y old boys, it was 6048 and 49392 l for the light and heavy activity level, respectively. The 8h working volume for the 15-y old girls was 5088 and 27552 l, respectively for the light and heavy activity stages. The adult male 8h volumes were 2448, 4896 and 41760 l for the resting, and light and heavy activity stage, respectively. In the female counterpart, the equivalent values were 2016, 4032 and 25200 l for each level [23].

Water balance

As presented in Table XI, the average total daily intake of water in 18 to 21-y males was 3312 g under the experimental conditions, in spring 1990. The elimination through urine, feces, and breath and sweat pooled were 1218, 182 and 1908 g in average, respectively with the total elimination 3308 g [27]. For 18 to 22-y females, the average total water intake was 2738 g under the conditions used, in summer 1990. The elimination via urine, feces, and breath and sweat pooled were 1008, 67 and 1666 g, with a total elimination 2741 g. The daily elimination of water normalized to the body weight was 31.9 $\pm$ 4.1 and 31.9 $\pm$ 4.4 g/kg for males and females, respectively [27]. Exact values of water intake were not obtained in this study.

TABLE II. BODY HEIGHT AND WEIGHT FOR REFERENCE JAPANESE MALE AND FEMALE (20-50 y)

Sex	Total body	Present work (1988)	ICRP Ref. Man (1975)
Male	Height (cm)	170	170
	Weight (kg)	60	70
Female	Height (cm)	160	160
	Weight (kg)	52	58

TABLE III. MASS OF ORGANS OF NORMAL JAPANESE OF DIFFERENT AGE GROUPS (g)

Organ	1 y		5 y		10 y		15 y		Adult	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Brain	1094	1025	1367	1302	1450	1325	1468	1331	1469	1331
Pituitary gland	0.22	0.25	0.29	0.30	0.40	0.45	0.53	0.61	0.57	0.64
Thyroid gland	2.3	2.4	4.5	4.6	8.4	8.6	15.5	15.0	19.0	16.9
Thymus	27.1	27.5	34.7	31.0	41.5	32.4	36.7	31.8	31.0	29.6
Heart	50	52	102	103	176	180	290	239	362	306
Lungs	189	176	322	286	542	472	930	678	1151	860
Left	84	81	151	131	257	219	456	310	534	388
Right	105	95	171	155	285	253	474	368	617	475
Liver	380	370	626	601	1005	974	1374	1243	1585	1358
Spleen	36	33	59	58	88	87	118	112	141	128
Pancreas	23	20	44	39	71	65	100	89	129	109
Kidneys	66	64	118	104	185	169	254	229	318	278
Left	33	33	60	53	95	86	131	116	164	143
Right	33	31	58	51	90	83	123	113	154	135
Adrenal glands	4.46	4.15	5.57	5.60	8.14	8.14	11.31	10.62	14.02	12.54
Left	2.28	2.14	2.81	2.86	4.13	4.17	5.76	5.45	7.25	6.47
Right	2.18	2.01	2.76	2.74	4.01	3.97	5.55	5.17	6.77	6.07
Testes	2.64	-	3.11	-	4.71	-	33.39	-	37.05	-
Left	1.31	-	1.50	-	2.19	-	16.47	-	18.15	-
Right	1.33	-	1.61	-	2.52	-	16.92	-	18.90	-

TABLE IV. MASSES OF THE MINERAL BONE AND ESTIMATED MASS OF THE ACTIVE RED MARROW IN THE JAPANESE ADULT MALE (g)

Bone	Mineralized bone		Wet bone	Red marrow
	Mean*	S.D.	(estimated)	(estimated)
Head	694.9	51.7	730	135.0
Cranium	602.3	50.8		
Mandible	92.6	11.7		
Clavicles	48.1	2.9	52	14.4
Scapulae	130.3	9.3	140	45.0
Ribs (12)	283.5	23.4	307	92.4
Sternum	20.8	3.5	23	20.8
Vertebrae	372.1	31.7	406	264.9
Cervical (7)	61.7	3.8		
Thoracic (12)	166.8	14.6		
Lumbar (5)	144.8	16.2		
Sacrum	94.6	10.5	102	129.5
Coxa	376.1	24.2	402	207.3
Upper limbs	576.9	30.9	631	17.7
Humerus (2)	284.4	16.0		
Radius (2)	85.6	6.0		
Ulna (2)	107.1	7.9		
Hand (2)	99.8	11.0		
Lower limbs	1569.8	75.7	1706	35.4
Femur (2)	745.1	38.2		
Patella (2)	29.4	2.3		
Tibia (2)	436.8	34.9		
Whole skeleton	4167.2	122.9	4500	962.4

* Mean and S.D. for the number of subjects 17.

TABLE V. CONTENT OF LIPID, LEAN BODY MASS (LBM), PROTEIN, MINERAL AND BODY WATER OF JAPANESE OF VARIOUS AGES

Sex	Age	B.W. (kg)	Lipid (% B.W.)	Lipid (kg)	LBM (kg)	Mineral (kg)	Protein (kg)	Water (% B.W.)	Water (kg)
Male	Newborn	3.22	11.6	0.37	2.85	0.07	0.20	80.0	2.58
	0-1 m	4.42	12.0	0.53	3.89	0.10	0.28	79.41	3.51
	2-3 m	5.78	12.0	0.69	5.09	0.12	0.45	78.20	4.52
	1 y	10.66	12.3	1.31	9.35	0.60	1.72	65.94	7.03
	5 y	18.46	14.3	2.64	15.82	1.32	3.78	58.07	10.72
	10 y	30.33	18.1	5.49	24.84	2.16	6.21	54.30	16.47
	15 y	53.70	16.6	8.91	44.79	3.13	9.09	60.64	32.57
	20 y	59.40	15.9	9.44	49.95	3.21	9.21	63.19	37.53
	20-25 y	59.67	16.8	10.03	49.64	3.22	9.20	62.38	37.22
Female	Newborn	3.19	11.5	0.37	2.82	0.07	0.20	80.00	2.55
	0-1 m	4.22	12.0	0.51	3.71	0.34	0.34	79.71	3.36
	2-3 m	5.74	12.1	0.69	5.05	0.61	0.61	74.66	4.29
	1 y	10.36	12.3	1.27	9.09	1.56	1.56	67.43	6.99
	5 y	18.00	14.6	2.63	15.38	3.71	3.71	57.63	10.38
	10 y	30.54	20.2	6.17	24.37	6.03	6.03	53.17	16.24
	15 y	49.46	25.0	12.37	37.10	8.18	8.18	52.64	26.04
	20 y	50.92	23.6	12.02	38.90	8.20	8.20	54.76	27.88
	20-50 y	50.96	25.7	13.11	37.85	8.23	8.23	52.46	26.73

TABLE VI. PER CAPUT DAILY CONSUMPTION OF CATEGORIZED FOODS AND ENERGY (g)

Food or energy	Mean	S.D.
Energy (kcal)	2153.7	
Cereals	322.1	86.6
Nuts and seeds	1.5	5.2
Pulses	67.7	47.1
Nuts, seeds & pulses	69.2	
Potatoes and starches	62.1	46.1
Sugars	13.0	10.4
Confectionaries	25.6	48.6
Sugars and Confectionaries	38.6	
Fats and oils	17.7	11.7
Fruits	164.9	118.5
Green and yellow vegetables	59.1	44.0
Other vegetables (including fungi)	200.4	90.0
Total vegetables	259.5	
Algae (mostly marine, dried)	5.2	7.3
Fish and shellfish	91.3	52.9
Meats	69.3	41.8
Eggs	40.3	23.0
Milk and milk products	114.5	90.7
Seasonings and beverages	114.9	160.5
Others	12.8	11.3
Total seasonings	127.7	

TABLE VII. DAILY DIETARY INTAKE OF ELEMENTS BY ADULT JAPANESE MALE

Element	Unit	Mean	Min.	Max.
Aluminum	mg	3.95	1.07	10.3
Barium	μg	358	156	645
Calcium	mg	563	238	1890
Cerium	μg			
Chlorine	mg			
Copper	mg	1.28	0.426	2.58
Iodine	mg	(0.5-1)		
Iron	mg	11.4	6.9	16.4
Lanthanum	μg			
Magnesium	mg	196	89	303
Manganese	mg	3.35	1.83	4.60
Phosphorus	mg	922	552	1270
Potassium	mg	1880	910	4350
Sodium	mg	4460	2340	6470
Strontium	mg	2.26	0.93	3.30
Sulfur	mg			
Thorium	μg	0.412	0.109	1.17
Uranium	μg	0.712	0.243	1.50
Zinc	mg	7.10	4.16	11.4

TABLE VIII. DAILY INTAKE OF ELEMENTS BY JAPANESE ADULT STUDIED BY THE DUPLICATE PORTION METHOD

Element	Sapporo 1967	Kyoto 1967-68	31 locations 1981-82	Mito 1983-84	Takamatsu 1986	All Japan estimate	Per cent ICRP Ref. Man
Na (g)	5.05	4.42	4.5	4.76	4.73	5.2	118
K (g)	1.92	1.53	1.9	2.41	2.79	2.0	61
Ca (g)	0.486	0.542	0.56	0.718	0.63	0.55	50
P (g)	1.07	0.899	0.92	1.20	1.20	1.0	71
Mg (g)	0.210	0.178	0.20	0.245	0.28	0.21	62
Fe (mg)	13.2	9.84	-	11.5	7.8	11	69
Zn (mg)	7.58	6.53	7.1	8.87	7.9	7.6	58
Al (mg)	5.14	4.57	4.0	4.23	2.3	4.5	10
Mn (mg)	3.77	3.95	3.4	4.29	4.1	3.8	103
Sr (mg)	2.04	1.94	2.3	2.84	-	2.3	121
Rb (mg)	2.10	1.64	-	-	-	2.2	100
Cu (mg)	1.40	1.14	1.3	1.25	1.4	1.3	37
Ba (mg)	0.453	0.410	0.36	0.482	0.42	0.43	57
Mo (mg)	1.037	0.195	-	0.215	0.29	0.18	60
Y (ug)	3.1	2.8	-	4.8	-	4	-
Th (ug)	-	-	0.412	-	-	0.41	14
U (ug)	-	-	0.712	-	-	0.71	37

TABLE IX. TOTAL LUNG CAPACITY AND VITAL CAPACITY OF NORMAL JAPANESE (LITER)

Sex	Age (y)	No. of people	Total lung capacity		Vital capacity	
			Mean	S.D.	Mean	S.D.
Male	16-19	10	5.24	0.68	4.10	0.44
	20-29	37	5.58	0.69	4.37	0.49
	30-39	76	5.67	1.00	4.23	0.65
	40-49	79	5.53	0.83	4.00	0.55
	16-79	342	5.51	0.88	3.89	0.66
Female	16-19	11	3.75	0.39	2.98	0.25
	20-29	24	3.91	0.49	3.00	0.39
	30-39	23	4.14	0.65	3.03	0.47
	40-49	23	4.09	0.84	2.74	0.46
	16-79	131	3.98	0.65	2.75	0.46

TABLE X. MINUTE VOLUME AND 8h WORKING VOLUME OF NORMAL JAPANESE

Sex	Age (y)	Minute volume (1/min)			8h working volume (1)		
		Resting	Light	Heavy	Resting	Light	Heavy
Male	Newborn	1.6	3.2		768	1536	
	1 y	2.9	5.8		1392	2784	
	5 y	4.2	8.4	40.1 (n = 46)	2016	4032	19248 (n = 46)
	10 y	5.3	10.6	50.4 (n = 16)	2544	5088	24192 (n = 16)
	15 y	6.3	12.6	102.9 (n = 17)	3024	6048	49392 (n = 17)
	20-50 y	5.1	10.2	87.0 (n = 123)	2448	4896	41760 (n = 123)
Female	Newborn	1.6	3.2		768	1536	
	1 y	2.8	5.6		1344	2698	
	5 y	3.9	7.8	36.0 (n = 39)	1872	3744	17280 (n = 39)
	10 y	5.1	10.2	40.0 (n = 16)	2448	4896	19200 (n = 16)
	15 y	5.3	10.6	57.4 (n = 15)	2544	5088	27552 (n = 15)
	20-50 y	4.2	8.4	52.5 (n = 9)	2016	4032	25200 (n = 9)

TABLE XI. WATER BALANCE IN YOUNG, NORMAL JAPANESE MALES AND FEMALES UNDER SOME CONTROLLED CONDITIONS

Sex	Age (y)	No. of people	Daily intake (g) (Water, milk, other liquid food)	Daily elimination (g)		
				Urine	Faeces	Sweat & breath
Male	18-21	9	3312.2 ± 139.5	1218.3 ± 69.3	181.5 ± 55.4	1908.4 ± 169.5
					Total = 3308.2	
Female	19-22	6	2737.8 ± 179.7	1007.7 ± 105.0	67.2 ± 13.6	1665.8 ± 230.4
					Total = 2740.7	

CONCLUSIONS

The physical and anatomical data for normal Japanese have been updated to provide representative and reference values which will establish a firm basis for modelling Reference Japanese Man, as well as Reference Asian Man for radiation protection dosimetry.

The dietary data represent the whole country. The elemental intake is considered to well represent the all districts of Japan. However, some elements including iodine need a little further study to specify representative values of daily intake and its variation.

Data on pulmonary function and water balance were obtained from a relatively small number of subjects. However, they still provide useful quantitative information for internal dose assessment.

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ESTABLISHMENT OF REFERENCE MAN IN THE REPUBLIC OF KOREA

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Abstract

The project on the Reference Korean was initiated in 1980. Physical data have been compiled for 21,406 Korean people, corresponding to 0.05% of total Korean population. All the data were divided into small groups according to the age and sex.

Internal organ mass data are cited from a report previously prepared the Chungham National University. The mass of Korean organs is similar to that of Japanese, but the weights of liver and pancreas were different with those of Japanese. This might be caused by the difference of the criterion of weighing methods but not by the real difference.

INTRODUCTION

There are two modes of exposure to radiation. One is the external exposure to natural radiation such as ^{40}K, uranium and thorium series radionuclides, and cosmic rays, as well as environmental radiation released directly from nuclear facilities. The other is the internal exposure to radiation released from natural or man-made radioactive substances inhaled or ingested through food chains.

Since radiation is known as a strong mutagen and a factor to induce life shortening in animals, there has been a strong effort to establish the acceptable maximum allowable level of exposure dose of radiation. Such maximum permissible exposure dose is applicable to man directly in case of external exposure, but quantitative data about the behavior of radioisotopes in the environment, bioaccumulation factor of radioisotopes and metabolism of radioisotopes are needed for the evaluation of radiological impacts on human population when it is internal exposure. With this viewpoint, Committee II of ICRP has compiled human characteristics as "Standard Man" in 1959 [1]. Later the Committee recompiled the data as Reference Man [2] in 1975 upon addition of supplementary data. The Japanese investigators have collected their specific anatomical and chemical data as "Reference Japanese" [3] since 1970 because their habitat and customs are different from those of the Caucasian.

When the levels of radiation exposure doses are sufficiently low, the values of Reference Man or Reference Japanese can no longer be applicable to the Korean population because of differences existing between the races and environments. Local specific data, therefore, are needed to obtain the precise estimation of radiation exposure doses for a given Korean. The project on the Reference Korean was planned and has been in progress since 1980. Some of the results are reported [4,5]. The present report is concerned with the human physiques of the Reference Korean.

METHODS

In order to determine the physical standards of Reference Korean, we have collected the data from the Industrial Advancement Administration [6] and recompiled them. Physical data of 21,406 Korean that corresponds to 0.05% of total Korean population were compiled. All the data were divided into small groups according to the age and sex. Surface area was not measured directly but calculated using the equation of Du Bois and Du Bois [7]. Data on the mass of Korean internal organs were collected and analyzed by us already (1,344 in male

TABLE I. NUMBER OF INDIVIDUALS ANALYZED

Age	Region								Total		
	Seoul Kyung-gi		Kang-won Chung-cheong		Pusan Kyung-sang		Chon-ra Che-chu				
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
0 - 5	595	538	478	331	116	107	186	141	1,372	1,117	2,489
6	59	57	117	108	32	57	19	15	227	237	464
7	57	49	144	104	66	87	38	39	305	279	584
8	65	76	135	135	85	78	22	23	307	312	619
9	69	57	135	116	80	72	24	30	308	275	583
10	51	53	145	100	58	40	48	41	302	234	536
11	33	24	140	134	33	48	39	35	245	241	486
12	65	73	346	231	17	10	18	96	445	410	855
13	109	174	322	314	1	3	4	115	436	606	1,042
14	104	160	339	346	1	1	9	126	453	633	1,086
15	209	163	280	298	52	140	99	161	640	762	1,402
16	278	178	212	365	105	188	146	207	741	938	1,679
17	167	79	181	267	117	193	123	170	588	709	1,297
18	307	70	293	88	188	240	237	94	1,025	492	1,517
19	427	67	389	26	259	69	341	84	1,416	246	1,662
20	228	75	163	17	189	15	134	77	714	184	898
21 - 25	765	201	219	51	353	27	138	159	1,475	438	1,913
26 - 30	713	175	69	21	184	10	9	12	975	218	1,193
31 - 35	75	230	58	12	12	17	3	7	148	266	414
36 - 40	38	136	122	23	1	13	1	2	162	174	336
41 - 50	65	204	174	16	6	9	3	1	248	230	478
51 -	3	29	24	57	0	2	0	0	27	88	115
Sum	4,481	2,868	4,485	3,160	1,955	1,426	1,638	1,635	12,559	9,089	21,648

TABLE II STATURES AS A FUNCTION OF AGE AND SEX

Age (Months)	Height - cm		Weight - kg		Sitting heights - cm		Acromion height - cm		Pubis heights - cm	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
36 - 41	96 7 ± 6 5	95 8 ± 4 6	15 4 ± 2 4	14 4 ± 1 3	56 2 ± 2 6	55 7 ± 2 3	74 3 ± 4 7	73 9 ± 5 1	39 2 ± 4 2	40 7 ± 3 0
42 - 47	100 2 ± 3 0	99 0 ± 2 4	15 6 ± 1 3	15 7 ± 1 5	57 9 ± 1 7	57 2 ± 2 0	77 1 ± 2 8	76 7 ± 2 3	41 6 ± 2 1	43 2 ± 1 9
48 - 53	103 4 ± 3 9	103 0 ± 3 9	16 9 ± 1 8	16 5 ± 1 9	59 2 ± 2 4	58 6 ± 2 4	80 0 ± 3 5	79 4 ± 3 9	43 3 ± 3 1	45 1 ± 3 5
54 - 59	106 8 ± 4 6	105 8 ± 4 6	18 0 ± 2 4	17 1 ± 2 1	60 7 ± 2 7	59 6 ± 2 6	82 7 ± 3 9	82 3 ± 4 3	45 9 ± 3 3	47 1 ± 3 4
60 - 65	109 3 ± 4 4	108 9 ± 4 1	18 5 ± 2 3	18 2 ± 2 3	61 6 ± 2 7	60 9 ± 2 5	85 0 ± 4 0	84 9 ± 3 8	47 6 ± 3 1	48 9 ± 3 0
66 - 71	111 8 ± 4 4	111 1 ± 4 1	19 4 ± 2 4	18 9 ± 2 3	62 8 ± 2 4	62 1 ± 2 3	87 1 ± 3 8	86 9 ± 3 5	49 9 ± 3 4	50 7 ± 3 1
6	117 0 ± 4 7	116 4 ± 4 4	20 8 ± 2 6	20 3 ± 2 6	64 8 ± 2 6	64 5 ± 2 5	91 7 ± 4 2	91 3 ± 4 0	52 2 ± 3 3	53 4 ± 2 9
7	121 5 ± 5 4	119 8 ± 5 0	22 8 ± 2 9	21 8 ± 3 0	67 0 ± 2 9	65 7 ± 2 6	95 6 ± 4 8	94 2 ± 4 6	54 9 ± 3 6	55 5 ± 3 6
8	126 5 ± 5 5	125 3 ± 5 3	25 5 ± 3 6	23 9 ± 3 5	68 8 ± 2 9	67 9 ± 2 8	100 2 ± 5 0	99 2 ± 4 7	59 0 ± 4 1	58 9 ± 3 6
9	131 3 ± 5 8	131 2 ± 5 6	27 7 ± 4 0	27 2 ± 4 3	70 8 ± 3 0	70 4 ± 3 1	104 2 ± 5 1	104 3 ± 5 0	61 6 ± 4 5	62 7 ± 3 7
10	135 8 ± 5 7	136 7 ± 6 2	30 7 ± 4 5	30 6 ± 5 1	72 6 ± 2 7	72 7 ± 3 4	108 4 ± 5 3	109 5 ± 5 4	64 9 ± 4 1	65 8 ± 3 8
11	140 4 ± 6 6	142 7 ± 6 8	33 4 ± 5 2	34 2 ± 6 1	74 7 ± 3 2	75 4 ± 3 7	112 5 ± 5 8	114 7 ± 6 2	67 0 ± 4 6	69 3 ± 4 3
12	147 0 ± 8 0	149 4 ± 6 5	38 2 ± 6 9	40 1 ± 6 8	77 5 ± 4 5	78 9 ± 4 0	118 4 ± 7 2	120 6 ± 5 6	69 7 ± 4 7	71 6 ± 4 0
13	153 4 ± 8 8	152 7 ± 5 7	42 4 ± 7 9	44 0 ± 6 8	80 7 ± 4 9	81 4 ± 3 4	124 0 ± 7 9	123 4 ± 5 1	72 4 ± 5 1	73 5 ± 3 7
14	160 1 ± 7 8	154 8 ± 5 1	48 4 ± 8 0	47 1 ± 6 5	84 0 ± 4 8	82 6 ± 3 0	129 9 ± 7 1	125 1 ± 4 5	75 6 ± 4 7	74 2 ± 3 8
15	164 2 ± 6 2	155 4 ± 4 9	53 2 ± 7 0	49 3 ± 5 8	87 1 ± 4 1	83 1 ± 2 8	133 6 ± 5 8	125 8 ± 4 4	77 9 ± 4 7	74 4 ± 3 5
16	166 5 ± 5 8	155 9 ± 5 1	56 2 ± 6 7	50 0 ± 5 8	88 9 ± 3 6	83 6 ± 2 9	135 4 ± 5 5	126 4 ± 4 6	78 9 ± 4 6	74 6 ± 3 4
17	167 0 ± 5 6	155 8 ± 2 8	57 1 ± 6 2	50 8 ± 5 4	89 6 ± 3 4	83 6 ± 2 7	136 0 ± 5 3	126 2 ± 4 4	78 9 ± 4 6	74 5 ± 3 4
18	167 9 ± 5 7	156 2 ± 4 8	59 1 ± 6 4	51 8 ± 5 6	90 1 ± 3 2	83 9 ± 2 6	136 6 ± 5 3	126 8 ± 4 4	78 2 ± 4 3	74 9 ± 3 5
19	168 3 ± 5 5	156 4 ± 5 4	59 7 ± 6 3	51 8 ± 5 8	90 5 ± 3 0	84 0 ± 2 8	137 0 ± 5 2	126 8 ± 4 4	78 9 ± 4 5	74 4 ± 3 4
20	168 6 ± 5 2	156 0 ± 4 6	60 8 ± 6 1	51 9 ± 5 8	90 9 ± 2 9	84 0 ± 2 9	137 6 ± 4 9	126 6 ± 4 1	79 6 ± 4 3	73 5 ± 3 0
21 - 25	167 7 ± 5 4	155 4 ± 5 2	60 8 ± 6 7	51 2 ± 6 0	90 6 ± 2 8	83 6 ± 2 9	137 1 ± 4 9	126 0 ± 4 8	79 2 ± 4 4	73 5 ± 3 6
26 - 30	166 6 ± 5 4	155 2 ± 4 7	61 7 ± 7 6	51 6 ± 6 1	90 1 ± 3 0	84 3 ± 2 8	136 2 ± 5 1	126 1 ± 4 2	77 9 ± 4 3	73 3 ± 3 4
31 - 35	167 9 ± 5 4	154 5 ± 4 9	64 5 ± 7 9	53 0 ± 6 7	90 8 ± 2 8	83 9 ± 2 8	137 3 ± 5 1	125 7 ± 4 5	78 6 ± 4 8	72 9 ± 3 7
36 - 40	166 8 ± 5 5	154 9 ± 5 2	65 1 ± 7 7	54 5 ± 6 6	90 0 ± 3 1	84 0 ± 2 9	136 4 ± 5 1	126 0 ± 4 6	76 9 ± 4 4	73 5 ± 3 4
41 - 50	165 8 ± 5 5	154 7 ± 4 6	65 2 ± 8 3	58 2 ± 6 8	89 4 ± 3 2	83 7 ± 2 8	135 1 ± 5 3	125 8 ± 5 6	76 0 ± 4 5	73 4 ± 3 9
51 -	166 2 ± 3 6	159 0 ± 5 3	61 5 ± 4 4	53 8 ± 9 6	89 7 ± 1 9	82 0 ± 3 2	134 7 ± 3 3	122 6 ± 5 4	74 6 ± 3 7	68 8 ± 3 8

TABLE III ANATOMICAL CIRCUMFERENCE VALUES AS A FUNCTION OF AGE AND SEX (cm)

Age (Months)	Chest		Abdomen		Head		Neck		Hip	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
36 - 41	51 6 ± 2 8	49 9 ± 1 6	48 8 ± 3 5	48 4 ± 2 9	49 5 ± 1 7	48 9 ± 1 1	24 1 ± 1 6	23 9 ± 1 1	52 5 ± 3 1	52 8 ± 2 4
42 - 47	51 9 ± 1 7	51 0 ± 1 3	49 2 ± 2 3	48 7 ± 2 4	50 3 ± 1 8	49 0 ± 1 1	24 3 ± 1 2	24 2 ± 1 1	53 1 ± 2 0	53 7 ± 2 4
48 - 53	53 4 ± 2 3	52 3 ± 2 3	50 0 ± 2 6	49 7 ± 3 2	50 4 ± 1 4	49 6 ± 1 7	24 9 ± 1 1	24 3 ± 1 2	54 5 ± 2 7	54 8 ± 2 7
54 - 59	54 6 ± 2 8	53 0 ± 2 7	51 2 ± 3 4	50 6 ± 3 5	50 7 ± 1 5	49 8 ± 1 5	25 3 ± 1 3	24 3 ± 1 3	55 9 ± 3 3	56 0 ± 3 0
60 - 65	54 7 ± 2 4	53 7 ± 2 4	51 3 ± 3 2	51 2 ± 3 5	50 9 ± 1 3	50 1 ± 1 3	25 2 ± 1 2	24 6 ± 1 2	56 4 ± 3 0	56 8 ± 3 3
66 - 71	55 9 ± 2 6	54 5 ± 2 6	52 0 ± 3 2	51 7 ± 3 6	51 3 ± 1 4	50 4 ± 1 3	25 3 ± 1 3	24 7 ± 1 2	57 6 ± 3 2	57 8 ± 3 5
6	57 1 ± 2 9	55 4 ± 2 8	54 5 ± 3 2	54 0 ± 3 2	51 3 ± 1 3	50 5 ± 1 4	25 6 ± 1 2	25 0 ± 1 3	59 0 ± 3 4	58 9 ± 3 2
7	58 9 ± 2 9	56 7 ± 3 1	55 5 ± 3 3	55 4 ± 3 9	51 9 ± 1 3	50 6 ± 1 4	26 1 ± 1 2	25 2 ± 1 3	61 4 ± 3 7	60 8 ± 3 7
8	60 9 ± 3 4	58 0 ± 3 4	57 2 ± 3 9	56 6 ± 3 8	52 0 ± 1 4	51 0 ± 1 4	26 6 ± 1 3	25 7 ± 1 4	63 7 ± 4 3	62 9 ± 4 0
9	62 3 ± 3 6	60 8 ± 4 2	58 6 ± 4 1	59 4 ± 4 9	52 2 ± 1 4	51 5 ± 1 4	27 1 ± 1 3	26 6 ± 1 7	65 7 ± 4 3	66 3 ± 4 8
10	64 7 ± 3 9	64 0 ± 5 0	60 8 ± 4 2	62 0 ± 4 5	52 6 ± 1 4	52 2 ± 1 4	27 7 ± 1 4	27 2 ± 1 6	68 3 ± 4 5	69 7 ± 4 9
11	66 6 ± 4 0	67 4 ± 5 6	62 1 ± 4 2	64 3 ± 5 1	52 8 ± 1 5	52 5 ± 1 5	28 3 ± 1 7	27 9 ± 1 7	70 4 ± 4 8	72 9 ± 5 7
12	69 8 ± 5 7	72 4 ± 6 2	64 7 ± 5 7	68 3 ± 5 8	53 2 ± 1 5	53 0 ± 1 5	29 6 ± 2 1	28 5 ± 2 0	74 5 ± 6 1	78 2 ± 6 0
13	72 5 ± 5 9	75 3 ± 5 9	65 7 ± 5 4	70 8 ± 6 0	53 6 ± 1 6	53 5 ± 1 4	30 7 ± 2 3		77 4 ± 6 1	82 0 ± 5 7
14	76 5 ± 5 6	78 0 ± 5 6	68 5 ± 5 2	73 1 ± 5 7	54 2 ± 1 5	53 9 ± 1 4	32 0 ± 2 4		81 4 ± 5 9	84 6 ± 5 1
15	79 8 ± 5 0	79 8 ± 5 0	69 7 ± 4 3	73 6 ± 5 2	54 5 ± 1 5	54 0 ± 1 4	33 0 ± 1 9		84 3 ± 4 8	86 7 ± 4 2
16	82 3 ± 4 4	80 5 ± 5 0	71 0 ± 3 9	74 4 ± 5 0	55 0 ± 1 5	54 0 ± 1 4	33 7 ± 1 8		86 1 ± 4 3	87 2 ± 4 3
17	83 1 ± 4 3	81 7 ± 5 0	71 2 ± 3 7	75 1 ± 5 3	55 0 ± 1 5	54 0 ± 1 3	34 1 ± 1 6		86 5 ± 3 8	87 9 ± 4 0
18	85 0 ± 4 6	82 5 ± 5 0	72 7 ± 4 1	75 9 ± 5 1	55 8 ± 1 5	54 3 ± 1 3	34 9 ± 1 6		87 5 ± 4 0	88 3 ± 4 0
19	85 7 ± 4 3	82 3 ± 4 9	73 4 ± 4 2	75 5 ± 5 4	55 8 ± 1 5	54 2 ± 1 3	35 0 ± 1 6		87 9 ± 3 9	88 3 ± 4 1
20	86 7 ± 4 5	82 4 ± 4 6	74 8 ± 3 9	75 3 ± 4 7	55 6 ± 1 5	54 2 ± 1 3	35 1 ± 1 5		88 6 ± 3 5	88 4 ± 3 6
21 - 25	87 3 ± 4 5	82 4 ± 5 0	75 6 ± 4 8	75 2 ± 5 4	55 9 ± 1 4	54 3 ± 1 3	35 4 ± 1 6		88 8 ± 4 0	87 8 ± 4 2
26 - 30	89 1 ± 5 1	82 8 ± 5 2	78 5 ± 6 1	77 2 ± 6 1	56 3 ± 1 5	54 4 ± 1 4	35 9 ± 1 8		89 5 ± 4 6	88 7 ± 4 4
31 - 35	90 7 ± 5 6	84 3 ± 6 0	80 9 ± 6 3	78 9 ± 6 7	56 4 ± 1 4	54 4 ± 1 4	35 9 ± 1 8		90 7 ± 4 6	90 0 ± 4 7
36 - 40	91 6 ± 5 6	86 2 ± 5 8	82 7 ± 6 6	81 3 ± 7 3	56 5 ± 1 6	54 6 ± 1 4	36 1 ± 1 9		91 2 ± 4 6	91 0 ± 5 0
41 - 50	92 2 ± 5 8	89 6 ± 6 7	84 1 ± 6 8	85 6 ± 6 9	56 2 ± 1 6	54 8 ± 1 3	36 5 ± 2 0		91 2 ± 4 6	92 9 ± 4 8
51 -	90 8 ± 4 5	88 3 ± 9 9	88 0 ± 6 8	91 0 ± 9 7	56 4 ± 0 9	54 6 ± 1 3	37 8 ± 1 7		93 0 ± 4 3	91 2 ± 6 8

TABLE IV ANATOMICAL DIMENSIONS AS A FUNCTION OF AGE AND SEX

Age (Months)	Thigh circumference		Waist circumference		Shoulder breadths		Arm lengths (shoulder to wrist)		Head lengths	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
36 - 41	29 7 ± 2 6	31 2 ± 1 7	48 8 ± 3 5	48 4 ± 2 9	26 1 ± 1 5	25 9 ± 1 1	29 8 ± 2 2	28 7 ± 1 7		
42 - 47	30 3 ± 1 1	31 6 ± 2 1	49 2 ± 2 3	48 7 ± 2 4	26 4 ± 1 3	26 4 ± 1 3	30 9 ± 2 3	30 5 ± 1 2		
48 - 53	31 5 ± 2 3	31 9 ± 2 3	50 0 ± 2 6	49 7 ± 3 2	27 5 ± 1 8	27 2 ± 2 0	32 5 ± 1 7	31 6 ± 1 8		
54 - 59	32 5 ± 2 4	32 6 ± 2 6	51 2 ± 3 4	50 6 ± 3 5	28 3 ± 2 1	27 9 ± 2 0	33 3 ± 2 1	32 9 ± 1 9		
60 - 65	32 5 ± 2 6	33 3 ± 2 5	51 3 ± 3 2	51 2 ± 3 5	28 4 ± 2 0	28 7 ± 1 9	34 2 ± 2 1	33 8 ± 1 9		
66 - 71	33 2 ± 2 4	34 0 ± 2 6	52 0 ± 3 2	51 7 ± 3 6	29 4 ± 2 1	29 4 ± 1 9	35 3 ± 1 9	34 7 ± 1 8		
6	33 7 ± 2 7	34 1 ± 2 6	51 7 ± 3 1	50 3 ± 3 4	30 6 ± 2 1	30 9 ± 1 7	36 9 ± 2 1	36 3 ± 2 0	16 7 ± 0 8	16 5 ± 0 8
7	35 0 ± 2 8	35 4 ± 2 7	52 9 ± 3 2	51 5 ± 3 7	31 4 ± 2 2	31 8 ± 1 9	38 6 ± 2 1	37 4 ± 2 1	16 9 ± 0 7	16 5 ± 0 7
8	36 9 ± 3 5	36 6 ± 3 1	54 5 ± 4 1	52 5 ± 3 7	32 2 ± 2 3	32 9 ± 1 9	40 7 ± 2 3	39 6 ± 2 3	16 9 ± 0 7	16 6 ± 0 7
9	38 0 ± 3 4	38 8 ± 3 5	55 7 ± 3 9	54 9 ± 4 8	33 3 ± 2 2	34 3 ± 2 3	42 3 ± 2 4	41 5 ± 2 3	17 0 ± 0 7	16 8 ± 0 7
10	39 9 ± 3 6	40 4 ± 3 6	57 5 ± 4 1	56 2 ± 4 1	34 4 ± 2 4	35 8 ± 2 6	43 9 ± 2 8	43 5 ± 2 6	17 1 ± 0 7	17 0 ± 0 7
11	41 1 ± 3 9	42 2 ± 3 9	58 7 ± 4 2	58 1 ± 4 7	35 4 ± 2 3	37 1 ± 2 2	45 4 ± 2 8	45 5 ± 2 9	17 1 ± 0 7	16 9 ± 0 6
12	43 4 ± 4 7	45 2 ± 4 5	61 6 ± 5 7	60 1 ± 5 0	37 1 ± 2 9	39 0 ± 2 3	47 8 ± 3 3	48 1 ± 2 6	17 2 ± 0 7	17 0 ± 0 7
13	44 7 ± 4 4	47 2 ± 4 3	62 7 ± 5 2	61 6 ± 5 2	38 7 ± 2 9	40 2 ± 2 2	49 9 ± 3 5	49 2 ± 2 7	17 3 ± 0 7	17 1 ± 0 6
14	47 1 ± 4 4	49 2 ± 4 2	65 4 ± 5 3	63 3 ± 5 1	40 4 ± 3 0	40 8 ± 2 1	52 2 ± 3 2	49 9 ± 2 3	17 5 ± 0 7	17 2 ± 0 7
15	48 7 ± 3 9	50 5 ± 3 6	67 0 ± 4 3	64 1 ± 4 7	41 7 ± 2 5	41 2 ± 2 0	53 7 ± 2 6	50 1 ± 2 2	17 6 ± 0 7	17 3 ± 0 7
16	49 8 ± 3 6	50 7 ± 3 5	68 7 ± 4 0	64 6 ± 4 6	42 3 ± 2 4	41 4 ± 1 9	54 7 ± 2 5	50 1 ± 2 2	17 8 ± 0 8	17 3 ± 0 6
17	49 9 ± 3 2	51 2 ± 3 2	69 0 ± 3 9	65 2 ± 4 7	42 3 ± 2 4	41 7 ± 1 9	54 7 ± 2 5	49 9 ± 2 1	17 8 ± 0 8	17 3 ± 0 7
18	50 7 ± 3 4	51 2 ± 3 2	70 4 ± 4 2	65 9 ± 4 4	43 1 ± 2 3	41 8 ± 2 0	54 9 ± 2 5	50 3 ± 2 1	17 8 ± 0 8	17 4 ± 0 6
19	50 7 ± 3 3	51 1 ± 3 0	71 3 ± 4 3	65 1 ± 4 6	43 3 ± 2 4	41 5 ± 2 0	55 1 ± 2 5	50 5 ± 2 5	17 8 ± 0 8	17 5 ± 0 6
20	51 0 ± 3 3	51 3 ± 2 8	72 8 ± 4 0	64 9 ± 4 1	43 6 ± 2 3	41 2 ± 1 9	55 5 ± 2 2	50 6 ± 2 4	17 9 ± 0 7	17 4 ± 0 7
21 - 25	51 2 ± 3 6	50 6 ± 3 3	73 7 ± 5 0	64 8 ± 4 5	43 2 ± 2 4	40 7 ± 1 9	55 3 ± 2 3	50 4 ± 2 3	18 0 ± 0 7	17 4 ± 0 6
26 - 30	51 4 ± 4 0	50 6 ± 3 7	76 9 ± 6 5	67 4 ± 6 2	42 8 ± 2 4	41 0 ± 1 8	55 5 ± 2 3	50 0 ± 2 0	18 1 ± 0 7	17 5 ± 0 6
31 - 35	52 6 ± 3 9	51 1 ± 3 6	79 8 ± 6 7	69 4 ± 6 2	43 3 ± 2 1	41 0 ± 2 0	54 6 ± 2 4	50 1 ± 2 1	18 3 ± 0 7	17 5 ± 0 6
36 - 40	52 7 ± 3 5	51 7 ± 3 4	81 8 ± 7 4	71 7 ± 6 7	43 0 ± 2 5	41 1 ± 2 0	54 4 ± 2 2	50 1 ± 2 0	18 4 ± 0 6	17 6 ± 0 6
41 - 50	51 7 ± 3 6	52 2 ± 3 4	83 2 ± 7 2	76 4 ± 6 8	42 9 ± 2 2	41 7 ± 1 9	54 1 ± 2 0	50 5 ± 1 9	18 3 ± 0 6	17 7 ± 0 6
51 -	50 9 ± 3 3	48 8 ± 4 7	86 5 ± 7 8	81 4 ± 12 1	43 2 ± 1 8	39 0 ± 2 7	56 7 ± 1 6	49 6 ± 2 0	18 0 ± 0 6	17 8 ± 0 6

TABLE V. ANATOMICAL DIMENSIONS AS A FUNCTION OF AGE AND SEX

Age (Months)	Head Breadths		Head Heights		Hip Breadths	
	Male	Female	Male	Female	Male	Female
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
6	14 8 ± 0 7	14 4 ± 0 7	20 1 ± 1 5	19 4 ± 1 9	20 1 ± 1 1	20 4 ± 1 1
7	14 9 ± 0 6	14 4 ± 0 6	20 5 ± 1 4	19 8 ± 1 2	20 9 ± 1 3	21 1 ± 1 3
8	15 0 ± 0 6	14 4 ± 0 7	20 5 ± 2 3	20 1 ± 1 4	21 8 ± 1 4	21 9 ± 1 4
9	15 0 ± 0 6	14 6 ± 0 6	21 0 ± 1 5	20 5 ± 1 6	22 6 ± 1 4	23 0 ± 1 6
10	15 1 ± 0 6	14 7 ± 0 6	21 1 ± 1 5	20 7 ± 1 5	23 6 ± 1 5	24 3 ± 1 7
11	15 2 ± 0 6	14 8 ± 0 6	21 3 ± 1 7	21 2 ± 1 5	24 3 ± 1 6	25 3 ± 2 2
12	15 3 ± 0 6	14 9 ± 0 6	21 7 ± 1 9	21 2 ± 1 8	25 6 ± 2 1	27 6 ± 2 2
13	15 4 ± 0 6	15 0 ± 0 6	21 8 ± 2 2	21 3 ± 1 6	27 0 ± 2 1	29 0 ± 2 0
14	15 6 ± 0 6	15 1 ± 0 6	22 2 ± 2 4	21 6 ± 1 4	28 5 ± 2 2	29 9 ± 1 8
15	15 6 ± 0 6	15 0 ± 0 6	22 3 ± 1 9	21 1 ± 1 6	29 4 ± 1 7	30 6 ± 1 5
16	15 7 ± 0 6	15 0 ± 0 6	22 5 ± 1 9	21 0 ± 1 4	30 0 ± 1 4	30 9 ± 1 4
17	15 8 ± 0 6	15 0 ± 0 5	22 4 ± 1 7	20 9 ± 1 3	30 1 ± 1 4	31 1 ± 1 4
18	15 8 ± 0 6	15 0 ± 0 6	22 7 ± 1 8	20 8 ± 1 5	30 4 ± 1 5	31 2 ± 1 4
19	15 8 ± 0 6	15 0 ± 0 5	22 6 ± 1 8	20 8 ± 1 2	30 5 ± 1 4	31 4 ± 1 3
20	15 8 ± 0 6	15 1 ± 0 6	22 2 ± 1 8	21 0 ± 2 5	30 6 ± 1 3	31 4 ± 1 4
21 - 25	15 9 ± 0 6	15 1 ± 0 6	22 2 ± 1 8	21 0 ± 1 1	30 6 ± 1 4	31 2 ± 1 5
26 - 30	15 9 ± 0 6	15 0 ± 0 6	22 3 ± 1 7	21 2 ± 1 1	30 7 ± 1 5	31 1 ± 1 3
31 - 35	16 1 ± 0 6	14 9 ± 0 6	22 2 ± 1 3	21 1 ± 1 1	31 3 ± 1 6	31 3 ± 1 7
36 - 40	16 0 ± 0 6	15 0 ± 0 7	22 6 ± 1 4	21 2 ± 1 1	31 2 ± 1 5	31 6 ± 1 7
41 - 50	16 1 ± 0 6	15 0 ± 0 7	22 3 ± 1 1	21 4 ± 1 8	31 1 ± 1 7	31 8 ± 1 4
51 -	16 3 ± 0 6	15 0 ± 0 6	22 8 ± 1 7	21 1 ± 1 7	31 8 ± 1 5	31 4 ± 1 5

TABLE VI. SURFACE AREAS AS A FUNCTION OF AGE AND SEX

Age	Male	Female
(Months)	Mean	Mean
36 - 41	6452 2	6210 1
42 - 47	6610 5	6591 8
48 - 53	6989 4	6892 8
54 - 59	7330 9	7111 8
60 - 65	7518 5	7443 6
66 - 71	7786 8	7661 7
6	8247 0	8128 4
7	8800 3	8544 5
8	9496 7	9150 2
9	10046 9	9987 5
10	10796 3	10814 4
11	11054 9	11680 3
12	12530 1	12940 5
13	13485 4	13704 6
14	14718 2	14277 0
15	15627 5	14633 9
16	16174 5	14761 8
17	16326 3	14874 0
18	16656 2	15039 3
19	16759 7	15048 9
20	16760 6	15044 3
21 - 25	16882 3	14918 0
26 - 30	16952 0	14961 9
31 - 35	17399 3	15129 6
36 - 40	17422 1	15361 6
41 - 50	17384 9	15865 3
51 -	16903 6	15020 4

TABLE VII. COMPARATIVE DATA OF THE PHYSICAL STANDARDS ACCORDING TO THE AGE (MALE)

Present Data						Korean Institute for Science and Technology					
Age	Stature	Weight	Chest Circ.	Waist Circ.	Neck Circ.	Age	Stature	Weight	Chest Circ.	Waist Circ.	Neck Circ.
6	117.0	20.8	57.1	51.7	25.6	6	113.9	19.7	57.0	52.5	26.7
7	121.5	22.8	58.1	52.9	26.1	7	119.1	21.3	58.4	52.6	26.3
8	126.5	25.5	60.3	54.5	26.6	8	124.4	24.0	62.4	53.9	26.9
9	131.3	27.7	62.3	55.7	27.1	9	129.5	26.7	61.9	55.3	27.6
10	135.8	30.7	64.3	57.5	27.7	10	133.3	29.1	65.0	56.9	28.1
11	140.4	33.4	66.6	58.7	28.3	11	138.3	32.6	67.4	58.5	28.8
12	147.0	38.2	69.8	61.6	29.6	12	142.6	34.7	69.3	59.8	29.4
13	153.4	42.4	72.5	62.7	30.7	13	149.8	40.1	73.1	62.8	30.4
14	160.1	48.4	76.5	65.4	32.0	14	156.7	45.6	76.5	64.8	31.6
15	164.2	53.2	79.8	67.0	33.0	15	161.8	50.3	80.1	66.9	32.7
16	166.2	56.2	82.3	68.7	33.7	16	165.5	54.3	82.5	68.4	33.5
17	167.0	57.1	83.1	69.0	34.1	17	167.6	56.7	84.5	69.7	34.0
18	167.9	59.1	85.0	70.4	34.9	18-19	166.8	58.8	87.1	72.2	34.7
19	168.3	59.7	85.7	71.3	35.0	20-24	167.7	61.3	89.0	74.5	35.3
20	168.6	60.8	86.7	72.8	35.1	25-29	167.0	61.7	90.3	75.0	35.8
21-25	167.7	60.8	87.3	73.7	35.4	30-34	166.1	60.8	89.8	75.9	35.7
26-30	166.6	61.7	89.1	76.9	35.9	35-39	166.0	62.2	91.7	75.5	36.2
31-35	167.6	64.5	90.7	79.8	35.9	40-44	164.9	61.7	91.5	77.7	36.1
36-40	166.8	65.1	91.6	81.8	36.1	45	162.9	56.7	87.8	74.4	35.4
41-50	165.8	65.2	92.2	83.2	36.5						

TABLE VIII. COMPARATIVE DATA OF THE PHYSICAL STANDARDS ACCORDING TO THE AGE (FEMALE)

Present Data						Korean Institute for Science and Technology					
Age	Stature	Weight	Chest Circ.	Waist Circ.	Neck Circ.	Age	Stature	Weight	Chest Circ.	Waist Circ.	Neck Circ.
6	116.4	20.3	55.4	50.3	25.0	6	112.5	19.1	56.4	51.2	26.0
7	119.8	21.3	56.7	51.5	25.2	7	116.9	20.5	57.3	51.1	26.2
8	125.3	23.9	58.0	52.5	25.7	8	124.1	23.6	59.6	52.4	26.5
9	131.2	27.2	60.8	54.9	26.6	9	127.5	25.4	61.8	53.3	27.1
10	136.7	30.6	64.0	56.2	27.2	10	133.8	28.8	64.2	55.2	27.9
11	142.7	34.2	67.4	58.1	27.9	11	139.6	32.3	66.8	56.9	28.5
12	149.4	40.1	72.4	60.1	33.7	12	145.2	36.8	71.0	58.4	29.6
13	152.7	44.0	75.3	61.6	34.5	13	149.3	40.9	74.6	60.6	30.4
14	154.8	47.1	78.0	63.3	35.3	14	152.3	44.6	77.6	62.3	31.1
15	155.4	49.3	79.8	64.1	35.3	15	154.6	48.5	81.2	64.7	32.0
16	155.9	50.0	80.5	64.6	35.4	16	155.2	51.0	83.0	65.9	32.4
17	155.8	50.8	81.7	65.2	35.6	17	155.5	51.4	83.6	66.5	32.5
18	156.2	51.8	82.5	65.9	35.8	18-19	155.7	53.0	85.5	67.6	33.3
19	156.4	51.8	82.3	65.1	35.7	20-24	155.5	52.7	85.6	67.9	33.4
20	156.0	51.9	82.4	64.9	35.8	25-29	155.2	51.0	84.8	68.0	35.3
21-25	155.4	51.2	82.4	64.8	35.7	30-34	153.7	51.9	85.4	70.1	34.7
26-30	155.2	51.6	82.8	67.4	35.7	35-39	154.2	52.4	86.7	72.0	35.7
31-35	154.5	53.0	84.3	69.4	36.2	40-44	154.3	53.7	88.0	73.7	34.4
36.40	154.9	54.5	86.2	71.7	36.2	45	151.9	53.0	88.4	74.9	36.2
41-50	154.9	58.2	89.6	76.4	36.8						

TABLE IX. AVERAGE WEIGHT OF ORGANS OF THE KOREAN FEMALE AS COMPARED WITH THE DATA IN LITERATURES MASS UNIT: GRAM

Organ	Reference Korean (Present work)		Korean[9] (Lee & Roh)		Reference[3] Japanese		Reference man[2]	
	n	Mean value	n	Mean value	n	Mean value	n	Mean value
Adrenal gland								
Left	-	-	34	5.0	247	6.85	277	12.7 ±
Right	-	-	33	5.2	248	6.36		
Brain	307	-	87	1,231.6	197	1,308.00	1,330	1,220.0
Heart	364	301.6	118	220.7	181	284	-	275(240) ± ±
Kidney								
Left	363	114.2	118	117.1	183	145	1,014	275 ±
Right	362	113.5	12	115.9	184	135		
Liver	362	1,610.9	111	1,146.4	174	1,363	44	1,477
Lung								
Left	357	435.7	74	331.4	152	415	150	886 ±
Right	354	512.7	73	339.6	155	478		
Pancreas	250	54.0	52	85.5	218	111	79	84.8
Spleen	363	58.2	91	99.5	195	122	720	153
Thyroid gland	-	-	26	21.9	241	16.8	144	14.5

± Both organs
± ± Ref.

TABLE IX. AVERAGE WEIGHT OF ORGANS OF THE KOREAN FEMALE AS COMPARED WITH THE DATA IN LITERATURES MASS UNIT: GRAM

Organ	Reference Korean (Present work)		Korean[9] (Lee & Roh)		Reference[3] Japanese		Reference man[2]	
	n	Mean value	n	Mean value	n	Mean value	n	Mean value
Adrenal gland								
Left	-	-	34	5.0	247	6.85	277	12.7 ±
Right	-	-	33	5.2	248	6.36		
Brain	307	-	87	1,231.6	197	1,308.00	1,330	1,220.0
Heart	364	301.6	118	220.7	181	284	-	275(240) ± ±
Kidney								
Left	363	114.2	118	117.1	183	145	1,014	275 ±
Right	362	113.5	12	115.9	184	135		
Liver	362	1,610.9	111	1,146.4	174	1,363	44	1,477
Lung								
Left	357	435.7	74	331.4	152	415	150	886 ±
Right	354	512.7	73	339.6	155	478		
Pancreas	250	54.0	52	85.5	218	111	79	84.8
Spleen	363	58.2	91	99.5	195	122	720	153
Thyroid gland	-	-	26	21.9	241	16.8	144	14.5

± Both organs

± ± Ref.

TABLE X. AVERAGE WEIGHT OF ORGANS OF THE KOREAN MALE AS COMPARED WITH THE DATA IN LITERATURES MASS UNIT: GRAM

Organ	Reference Korean (Present work)		Korean[9] (Lee & Roh)		Reference[3] Japanese		Reference man[2]	
	n	Mean value	n	Mean value	n	Mean value	n	Mean value
Adrenal gland								
Left	-	-	112	5.0	1,127	7.65	328	13.8 ±
Right	-	-	112	5.0	1,189	7.03		
Brain	789	-	305	1,369.0	918	1,440.00	2,107	1,355.0
Heart	928	348.8	384	252.1	596	352	309	345(330) ± ±
Kidney								
Left	928	126.0	392	126.2	868	168	2,414	310 ±
Right	926	125.6	339	122.0	876	159		
Liver	920	1,863.9	328	1,211.6	856	1,600	150	1,831
Lung								
Left	885	548.8	123	369.0	715	539	259	1,169
Right	926	652.6	99	393.8	722	623		
Pancreas	659	56.4	227	89.7	1.17	135	131	96.1
Spleen	928	67.3	324	107.3	867	127	1,022	192
Thyroid gland	-	-	81	18.3	1,185	17.1	528	34.7

± Both organs

± ± Ref.2

and 577 in female) [8]. We cited the data in this report because of the insufficiency of the new data collected.

RESULTS AND DISCUSSION

Committee II of ICRP and NIRS of Japan has published extensive information on the anatomical, chemical and physiological standard of a Caucasian and Japanese as a Reference Man and Reference Japanese, respectively, for the purpose of estimation of internal exposure. However, the human models such as a Reference Man or Reference Japanese are based on the data obtained from Caucasians and Japanese. The Reference Man or Reference Japanese are not directly applicable to Koreans since the differences exist among Asians, Europeans and Americans with respect to races, customs and the patterns of food consumption.

In view of those problems, it is necessary obtain reference values for Korean, such as a physical standard, food consumption and mass or dimension of internal organs of individuals in Korea. We, therefore, collected the data on physical standards of Korean and compared them with those of former data [4], for the first year, in order to establish the Reference Korean.

First, the stature of Koreans was increased but the circumference was decreased when they are compared with those of 1979. These might be caused by the change of nutritional value and social behavior. Second, the physical values of females around 10 years old were greater than those of males with same age but it was reverted beyond the ages. This might be caused by the difference of onset age of the sexual maturation. Third, the size of head was invariable all over the ages. Fourth, the determination of body surface area is not easy whereas it is an important one for the evaluation of radiation exposure. Many methods to calculate the surface area of human beings have been developed [7, 9-11]. We adapted the method of Du Bois and Du Bois [7]. Finally, we compared these data with those of Reference Man and Reference Japanese. The values of Reference Korean were similar to those of Reference Japanese but different with those of Reference Man. The physical standards of Reference Korean and Reference Japanese were similar to those of Caucasians who are aged around 15. Since the values of Reference Korean are similar to those of Reference Japanese, the establishment of Reference Asian may be possible.

On the other hand, mass of internal organ was cited from the data of former report which was prepared by us because of the insufficiency of the new data. The mass of Korean organs is similar to that of Japanese, but the weights of liver and pancreas were different with those of Japanese. This might be caused by the difference of the criterion of weighing methods but not by the real difference.

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COMPILATION OF ANATOMICAL, PHYSIOLOGICAL AND METABOLIC CHARACTERISTICS OF REFERENCE ASIAN MAN IN PAKISTAN

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Abstract

A research programme was initiated in collaboration with IAEA/RCA to establish local sex specific data and latter on to contribute to define a reference Asian man/woman in the age range of 5, 10, 15, 20-29, 30-39, 40-49 and 20-50 years in order to strengthen the radiation protection infrastructure of the country. Physical data on height, weight, chest and head circumference and food consumption data of reference Pakistani man/women were collected from various socioeconomic strata residing at different ecological areas of Pakistan. The present study revealed that our daily nutritional status and all the physical parameters are significantly lower than ICRP reference man of Caucasian origin except the standing height of male. Since the anatomical organs are roughly proportional to body size so approximation can be made for internal dosimetry purposes with the same ratio as defined by those countries who experimentally established their values.

INTRODUCTION

The main objective of this pilot project was to compile anatomical, physiological and metabolic characteristics of a standard Pakistani man for the standardization of Asian Reference Man which can be used for the dose estimation of exposed individuals. This requires certain amount of data for the calculation of different kind of authorized limits & derived reference levels. Because it is prerequisite for radiation protection practices that radiation doses can be estimated for individual and population based on the results of monitoring & measurement of radiation exposure or in-vivo and in-vitro radioactivity.

For the more realistic estimation of doses and its distribution in the body, the real physical, physiological and metabolic characteristics for general public and radiation workers of various age, sex, socioeconomic, ethnic and religious groups were to be studied. The genetic, environmental and nutritional factors obtained, differ significantly from those of Caucasian as compared with Asian populations. Previously we were using ICRP reference values of adult Caucasian which does not provide a realistic estimation for local population due to the above mentioned factors. Thus it became essential to collect data from different Asian countries and compare it with Western countries. It may however be noted that these data may also differ widely from region to region within the Continent of Asia.

For the achievement of above mentioned purpose a decision was undertaken at the IAEA/RCA Project Formulation meeting for the "STRENGTHENING OF RADIATION PROTECTION INFRASTRUCTURE" in 1988. The main aim of the project was to collect:

1. Physical and anatomical data

2. Food consumption status

3. Physiological and Nutrient intake data

It is expected that these published estimates of reference man as defined here will be used for most purposes of planning in Radiotherapy, Nuclear medicine and for low level exposures without any tedious enumeration of assumptions and provide a baseline data to health physicist in nuclear emergencies.

MATERIAL & METHODS

Pakistan, as defined by 1981 population census, consist of four provinces i.e Punjab, Sind, North West Frontier Province (NWFP) and Baluchistan (including their urban and rural areas). Fig.1 (map of Pakistan) depicts percentage distribution of population for each province.

The sample size was designed by dividing Pakistani population in two groups i.e. urban and rural areas for the collection of physical parameters. For the food consumption study population of big cities i.e. Karachi and Lahore were sampled separately. The rest of urban population of all the provinces were grouped together to comprise urban areas of the nation. While the rural areas were comprised of villages belonging to each districts of Punjab, Sind, NWFP and Baluchistan.

Standard methods of measurement for the collection of physical parameters e.g. height, weight, chest & head circumference were adopted. The data collection were made in the age range of 5, 10, 15 and 20-50 years for both sexes at random from various public places like schools, colleges, universities and army units. So far data has been collected mostly from NWFP, Punjab and some parts of Baluchistan constituting approximately 75% of the total Pakistani population.

The nutritional survey of Pakistan [1] was started on a multi-centric basis. Dietary measurements of food for individuals was made just prior to eating. As food intake was a key component of the survey, a 24 hour actual dietary intake weighing of cooked foods method was adopted, i.e. the food intake at breakfast, lunch, dinner and in between were weighed and recorded on the dietary proforma. The record include both the type of food and its components.

The analysis considered three major areas:

1) Qualitative - Which food or combination of foods are eaten .
2) Amount of food eaten.
3) Nutrient intake - Calories, Protein and Iron.

Cooked food samples (from 10% of the sample households) were taken for the analysis of different nutrients to develop a cooked food table, which was used in part for the present survey. The dietary intake was later converted into nutrient intake by using the nutrient value of cooked dishes. 8483 subjects (representing 37% of all available subjects) were selected for editing, entry & analysis for national sample and a further 1888 from Azad Kashmir and Northern Areas.

The sample distribution was made according to rural, urban and city as well as biological and age groups. Variable grouping for food intake were as under:

CEREAL	Wheat (roti, paratha, weaning foods, rusk, biscuits), rice, corn.
MILK	Cow, buffalo, commercial(excluding bottle) Milk products - lassi, yogurt
ROOTS	Potatoes and other root vegetables

PULSES	Pulses, gram
MEAT	Beef, mutton and poultry
EGG	Any
FISH	Any
OILS	Ghee, other vegetable and animal fats.
VEGETABLES	All vegetable except dark green leafy, roots
FRUIT	Any
TEA	

RESULTS & DISCUSSION

Total data evaluations for physical characteristics i.e. standing height, weight, chest & head circumference of male/female in the age range of 5, 10, 15 and 20-50 years were made and details are given in Tables (1-8). Mean, median, standard deviation with No. of subjects of males & females in the age range of 0, 5, 10, 15, 20-29, 30-39, 40-49 & 20-50 years for height, weight, chest and head circumference are shown in Tables-1 & 2.

Figure 2 shows height of a male increases sharply from 0-15 years then there is slow trend from 15-39 years and then a slight decrease is noted after 40 years. This might be due to poor dietary conditions or decalcification of bone with the increase of age. But the overall height of a Pakistani man in the age range of 20-30 years is slightly greater than the Caucasian male [2] in spite of the differences in race, customs and dietary habits. Figure 2 also depicts that height of a Pakistani female initially increases with the same pattern as of male up to the age of 5 years. There is retarded growth from 5-10 years but after this age it increases sharply from 10-15 years and remains approximately constant for 20-29 years and then decreases slowly with the increase of age up to 40 years. An opposite trend is noted after 40 years as compared to males. Its comparative study with caucasian female [2] revealed that our Pakistani female is shorter in height.

In Figure 3, sex specific data of weight are plotted as function of age for Pakistani male/female population. The respective average values of weight of all age groups ranging from 0-49 years are 3.2 - 68.46 kg and 3.3 - 61.51 kg. It has been noted that weight of both sexes increases with age, but it is significantly less than adult Caucasian population [2]. Weight deficiency is also noted in females for the age group of 5 to 10 years. Comparison of height and weight of Pakistani population made with those of others countries [2-6] is shown in table-3.

Figure 4 shows the sex specific data of chest circumference that it increases with age for males as is the case for weight while in case of female chest circumference increases up to the age of 15 years and then does not increases with same ratio as that of male.

Sex specific data of head circumference is plotted as a function of age in Figure 5 which shows a significant increase up to the age of 20 years. For the age group of 20-40 years, it remains approximately constant. However, a small decrease is noted after this age. In the case of female, a decrease in head circumference is noted from 5-10 years and after 10 years, it increases sharply, attaining its maximum from 20-30 years, and then decreasing from 30 onwards. An opposite trend is observed after 40 as compared to males.

It has been noted in case of female children of 5-10 years that their body height, weight and head circumference are retarded as compared to our male children. The other observation, in most cases of female is that a number of physical parameters attain their maximum values at the age of 20-39 years. After this age the values decrease with increasing age. The probable explanation for this is that the female population who have reached the age group of 40 years and above were born and brought up under relatively poor hygienic and

% of total population

Punjab	=	56.1 %
Sind	=	22.6 %
NWFP	=	13.1%
Baluchistan	=	5.1 %
FATA	=	3.0 %

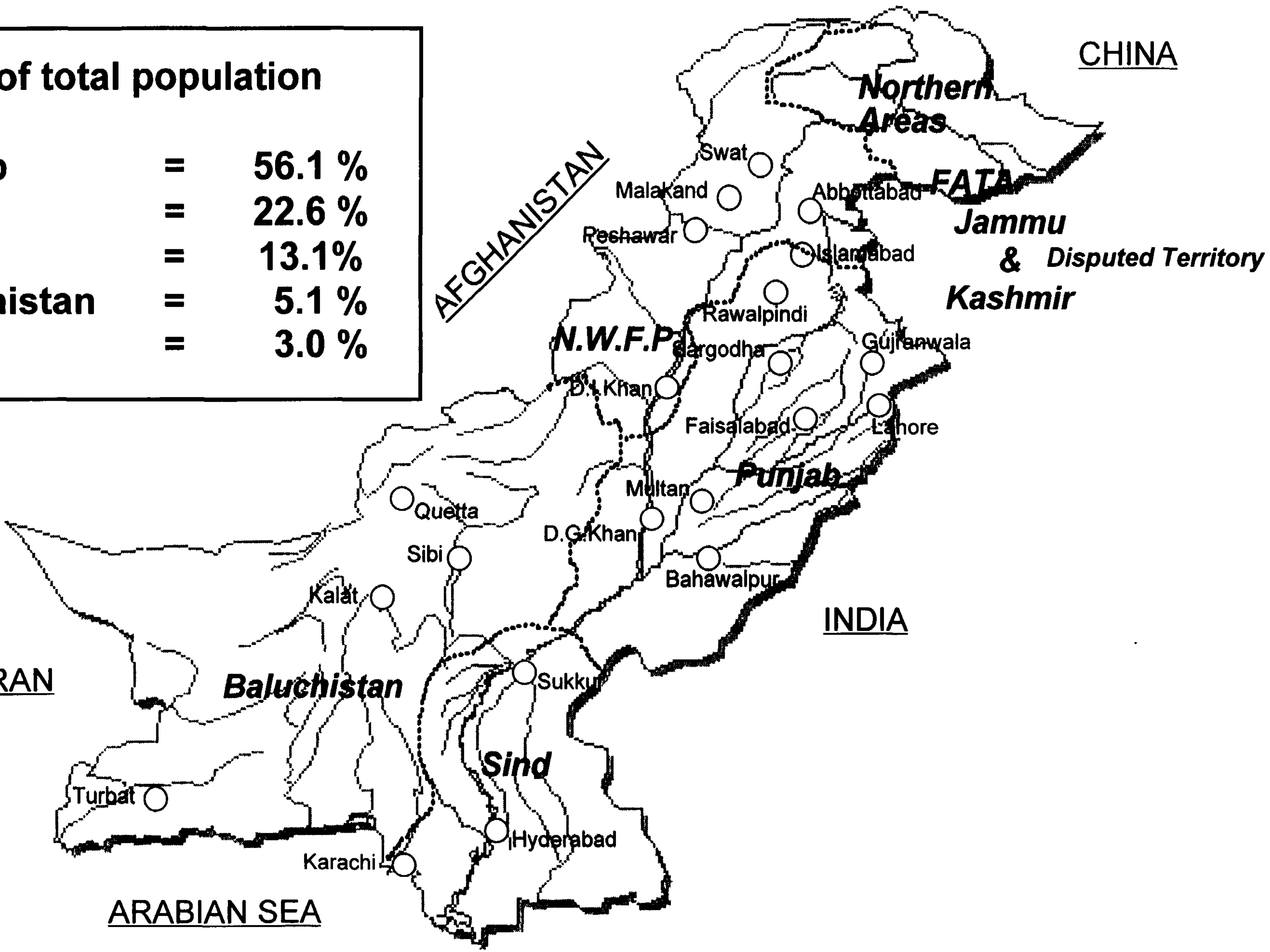

Fig. 1 Sample locations in Pakistan

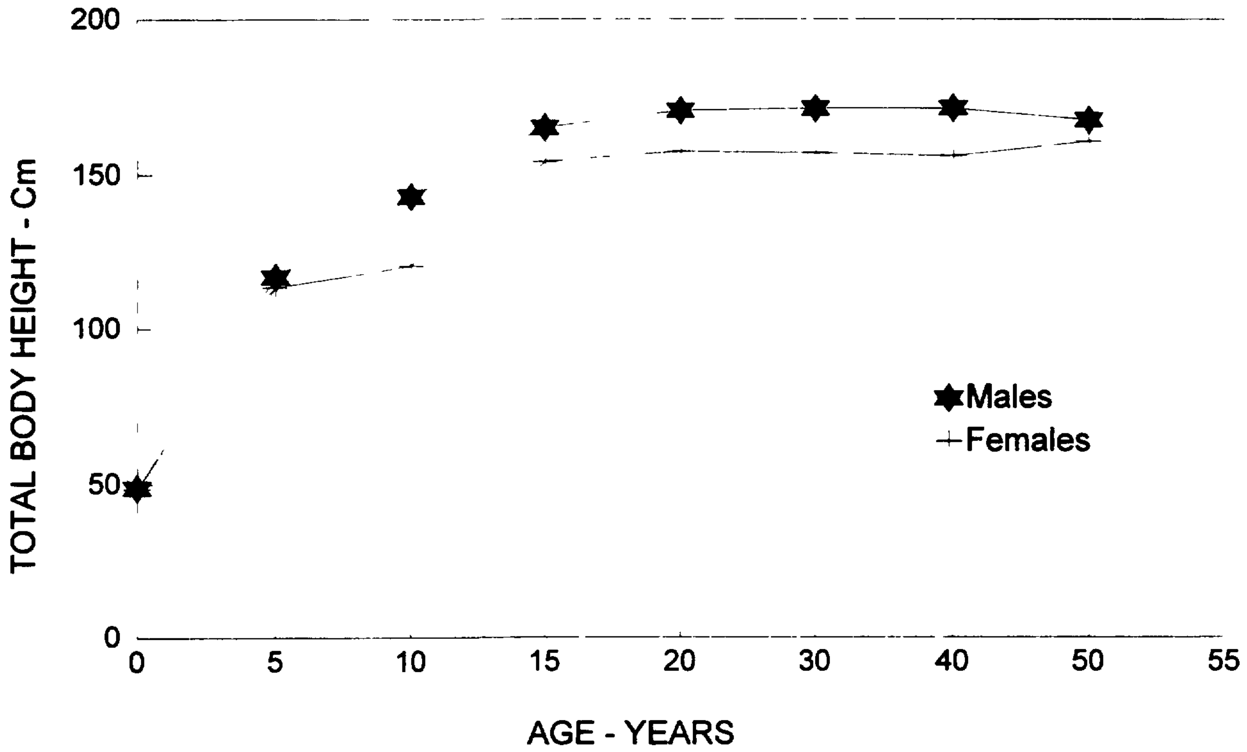

Fig. 2 Change in Body Height with Age

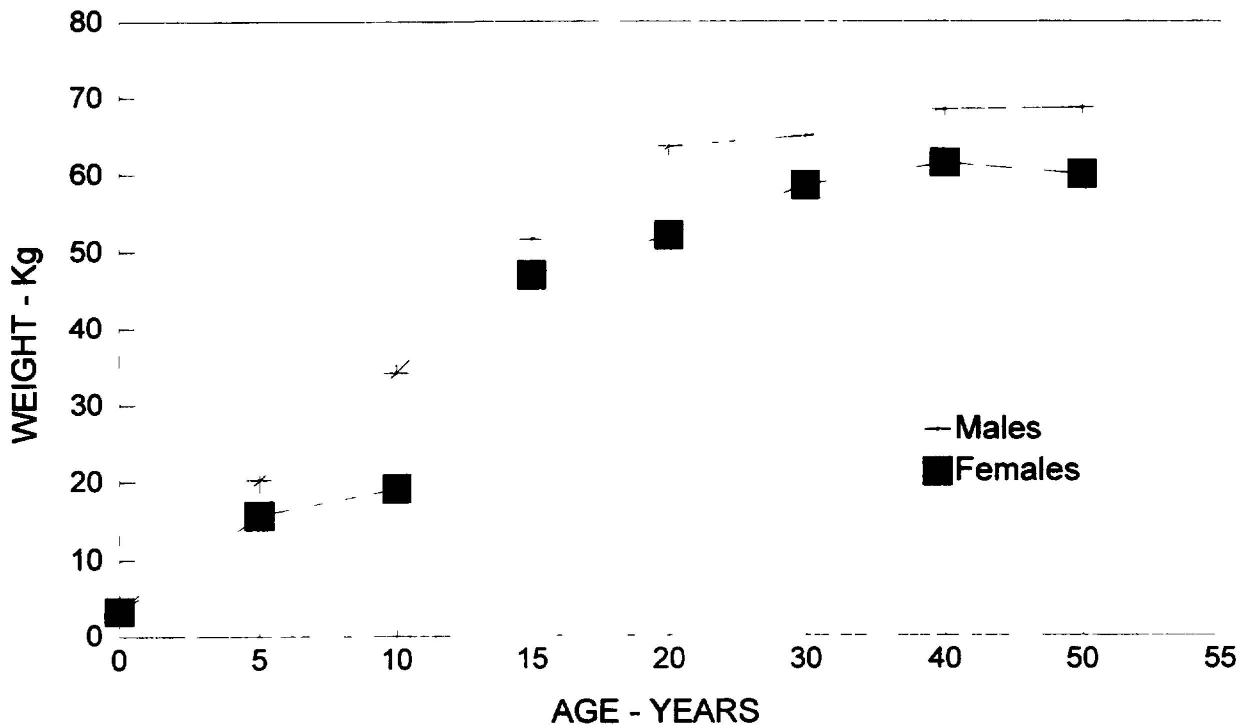

Fig. 3 Change in Body Weight with Age

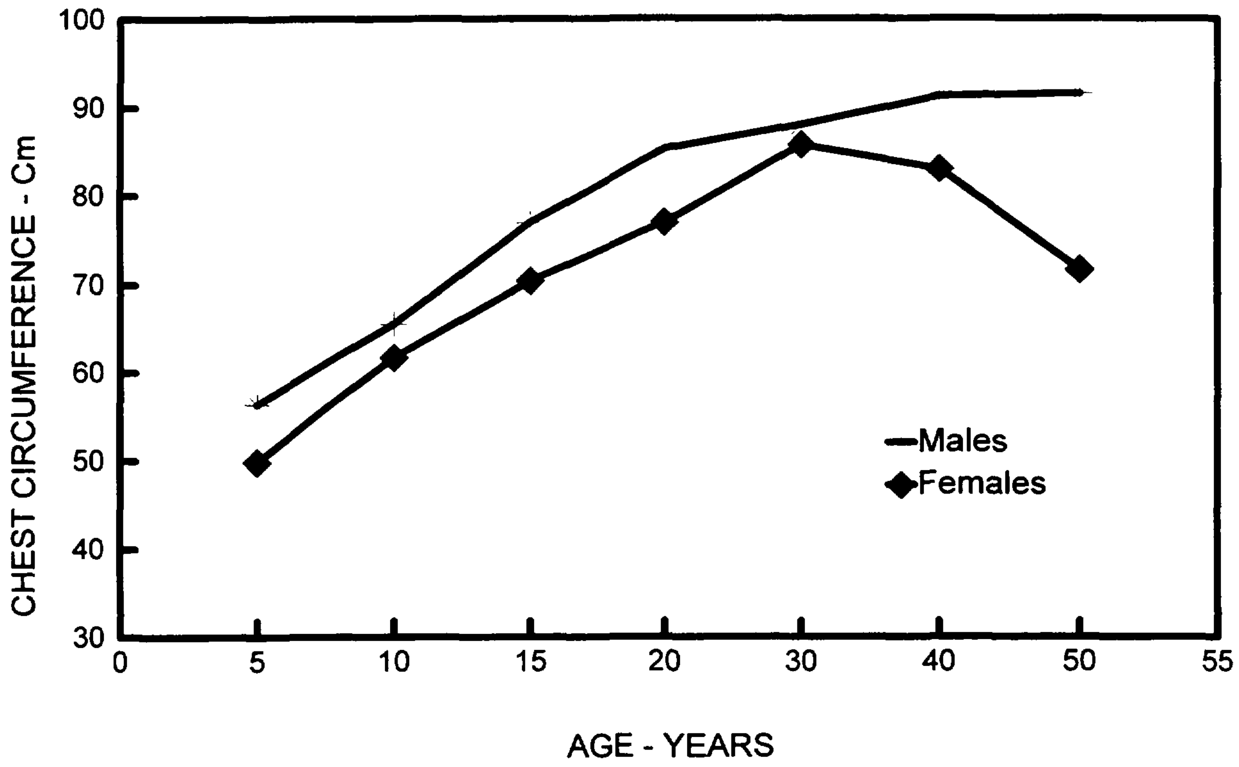

Fig. 4 Change in Chest Circumference with Age

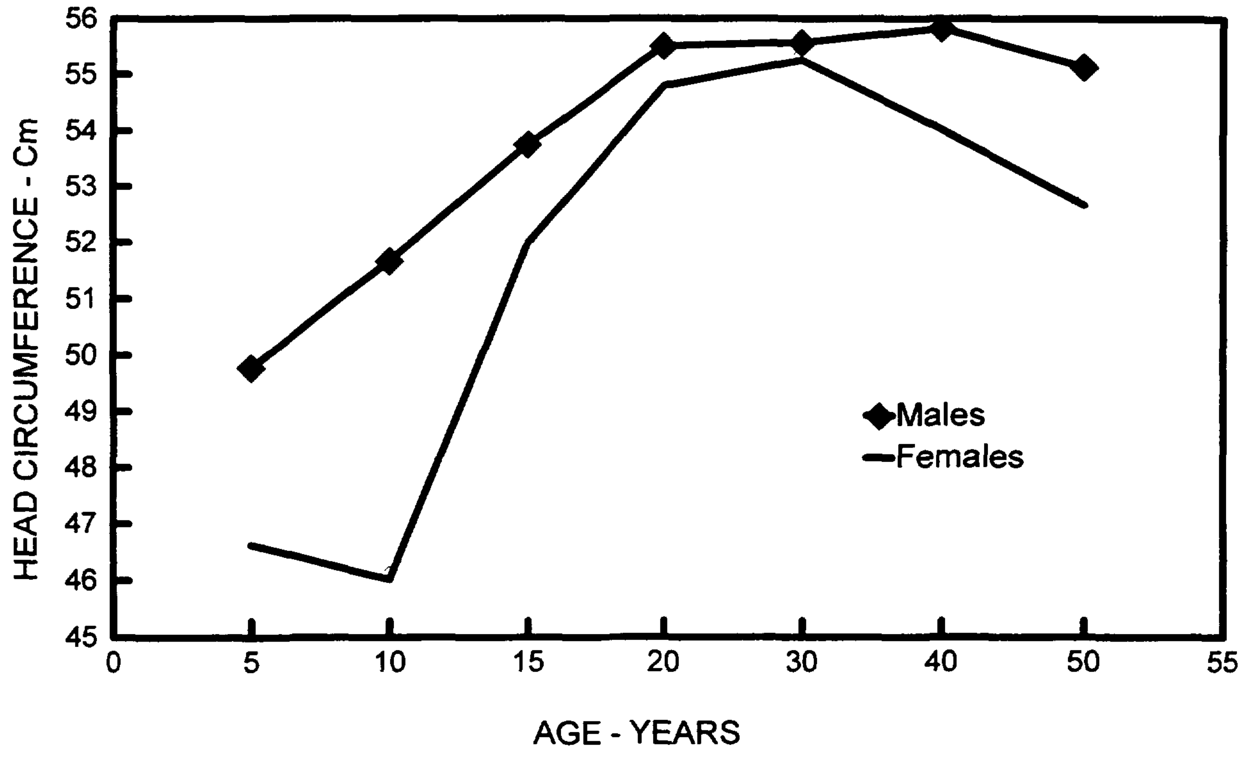

Fig. 5 Change in Head Circumference with Age

health care conditions as compared to our young generation. In addition there could be some decalcification of bone minerals which may be the cause of decreased values of some parameters. The physical characteristics of country are also influenced by its demographic pattern and socio-economic status.

FOOD CONSUMPTION

Results listed in table 4 are based on the percentage of subjects who took the particular food, mentioned earlier as variable grouping (or food group). This table shows that from the age of 6 years to adulthood the percentage of eating food is almost same for both sexes.

TABLE I. PHYSICAL MEASUREMENTS OF PAKISTANI MALE

Age Groups in Years	Height - cm (Median) Mean, S.D. (N)	Weight - kg (Median) Mean, S.D. (n)	Chest Cir. cm (Median) Mean, S.D. (N)	Head Cir. - cm (Median) Mean, S.D. (N)
00	(-) 48.8, 7.00 (63)	(-) 3.2, 0.6 (60)	- - -	- - -
05	(116.50) 116.84, 6.94 (1,652)	(20.00) 20.26, 3.01 (1,638)	(56.20) 56.38, 2.81 (1,655)	(50.00) 49.78, 1.47 (1,655)
10	(142.50) 143.02, 9.39 (2,370)	(34.00) 34.20, 7.04 (2,370)	(65.20) 65.54, 5.21 (2,370)	(51.50) 51.67, 1.69 (2,370)
15	(165.20) 165.08, 8.49 (4,745)	(51.00) 51.57, 8.77 (4,746)	(77.00) 76.94, 6.09 (4,733)	(54.00) 53.76, 1.79 (4,745)
20-29	(170.00) 170.55, 6.19 (16,515)	(63.00) 63.66, 7.72 (16,509)	(84.50) 85.32, 5.52 (16,514)	(55.50) 55.51, 1.35 (15,808)
30-39	(170.08) 171.17, 6.85 (1,792)	(64.00) 64.99, 9.28 (1,792)	(88.00) 88.01, 7.19 (1,792)	(56.00) 55.57, 1.79 (1,531)
40-49	(170.00) 171.31, 9.06 (469)	(67.00) 68.46, 12.33 (469)	(90.00) 91.29, 8.21 (469)	(56.00) 55.83, 1.84 (457)
20-50	(170.00) 170.62, 6.35 (18,823)	(63.00) 63.92, 8.09 (18,817)	(85.00) 85.75, 5.92 (18,821)	(55.50) 55.53, 1.42 (17,843)

S.D.= Standard Deviation
N = Number of people

Intake of foods

During this survey, it was found that the average intake of cereals in grams per day per capita was just over 500 grams. As expected, most of this (over 85%) was wheat usually in the form of roti. The results for other foods are presented in Table 5.

The average intake of cereals and milk appears much greater in rural as compared with urban and city areas. The consumption of tea varies greatly throughout the country ranging from 22-400 CC daily. Estimates for sugar were based on the amount of tea & milk drunk (average sugar added to milk 10% and to tea 15%). On the other hand much less meat appears to be eaten in rural areas. In table 5, data from Karachi & Lahore are shown separately as these cities have population greater than 500,000 and above. The amounts are under estimated because the food eaten outside the households was not known. This would also tend to reduce the estimates for cities as well as for the total country. A bar chart for this is shown in Figure 6. The average consumption of meat in city areas is consistently higher as compared with urban and rural areas. The consumption of egg, fish and fruit were appeared to be the lowest in country.

TABLE II. PHYSICAL MEASUREMENTS OF PAKISTANI FEMALE

Age Groups in Years	Height - cm (Median) Mean, S.D. (N)	Weight - kg (Median) Mean, S.D. (n)	Chest Cir. cm (Median) Mean, S.D. (N)	Head Cir. - cm (Median) Mean, S.D. (N)
00	(-) 48.5, 4.2 (54)	(-) 3.3, 0.5 (49)	- - -	- - -
05	(114.30) 113.53, 10.25 (82)	(16.00) 15.69, 2.50 (82)	(50.90) 49.85, 2.63 (82)	(45.72) 46.62, 2.30 (82)
10	(116.74) 120.39, 10.20 (71)	(17.00) 19.14, 5.09 (72)	(58.42) 61.71, 7.45 (73)	(43.18) 46.01, 4.13 (71)
15	(153.00) 154.21, 6.56 (344)	(48.00) 46.94, 7.22 (346)	(70.00) 70.40, 7.87 (348)	(53.00) 52.00, 1.97 (348)
20-29	(157.58) 157.52, 6.77 (974)	(51.80) 52.08, 8.12 (952)	(76.00) 76.97, 8.68 (974)	(55.00) 54.80, 2.13 (974)
30-39	(157.58) 157.05, 4.95 (51)	(59.00) 58.58, 9.59 (51)	(89.00) 85.74, 9.69 (48)	(55.88) 55.26, 1.69 (51)
40-49	(157.58) 156.07, 5.79 (18)	(64.53) 61.51, 13.40 (18)	(85.00) 83.00, 16.04 (18)	(53.67) 54.03, 1.82 (18)
20-50	(157.58) 157.48, 6.68 (1,046)	(52.00) 52.59, 8.51 (1,024)	(77.00) 77.47, 9.10 (1,043)	(55.00) 54.81, 2.11 (1,046)

S.D.= Standard Deviation
N = Number of people

TABLE III. COMPARISON OF PAKISTANI MALES/FEMALES WITH OTHER COUNTRIES

Sr. No.	Reference Country	Age Range (Years)	MALE Height cm	MALE Weight kg	FEMALE Height cm	FEMALE Weight kg
1.	Pakistan	20-29	170.55	63.66	157.52	52.08
2.	Caucasian [2]	20-30	170.00	70.00	160.00	58.00
3.	Japan [3]	20-50	165.00	60.00	155.00	51.00
4.	Korea [4]	20-30	167.00	61.00	155.00	51.00
5.	Philippines [5]	20-30	158.60	54.40	150.50	48.00
6.	Thailand [6]	15-65	165.00	55.00	154.00	48.00

TABLE IV. PERCENTAGE OF SUBJECTS EATING FOOD IN PAKISTAN

FOOD GROUP	CHILD AGED 2-2.5 Y	BOYS 6-15 Y	GIRLS 6-15 Y	MALE ADULTS	FEMALE ADULTS
CEREAL	61	99	99	99	99
MILK	36	44	43	43	42
ROOTS	12	27	26	29	30
PULSES	7	31	29	33	30
MEAT	1	39	35	35	37
EGG	7	12	12	9	10
FISH	1	4	5	3	3
OILS	34	96	96	97	97
VEGETABLES	8	43	44	45	44
LEAFY VEG.	1	7	7	5	6
FRUIT	9	6	7	5	7
TEA	27	69	73	74	77
SAMPLE SIZE	300	681	639	1,309	1,192

TABLE V. AMOUNTS OF FOOD EATEN(GRAMS/DAY) IN PAKISTAN

FOOD GROUP	RURAL	URBAN	CITY*	TOTAL
CEREAL	570	534	404	502
MILK	257	114	75	161
TEA	148	140	158	150
LEAFY VEGS.	14	16	3	10
VEGETABLES	80	77	83	81
PULSES	42	42	44	43
ROOTS	49	40	30	40
SUGAR	48	32	31	39
MEAT	26	42	53	39
OILS	29	36	36	33
FRUIT	4	7	13	8
EGGS	5	7	9	7
FISH	8	11	2	6

* Includes Karachi & Lahore

TABLE VI. AMOUNT OF NUTRIENT EATEN DAILY ACCORDING TO FOOD

Areas	Cereals	Animal	Milk	Pulses	Veg.	Fruit	Sugar	Oil	TOTAL
Pakistan	1310	125	115	73	111	5	150	290	2180
Rural	1488	94	163	71	122	3	185	255	2379
Urban	1394	144	92	71	113	5	123	317	2259
City	1054	154	74	75	99	8	119	317	1900
Punjab	*1300*	*89*	*163*	*70*	*130*	7	*166*	*326*	*2249*
Lahore	947	91	87	66	100	11	104	246	1653
Sind	1629	84	179	83	102	2	146	238	2463
Karachi	1081	175	50	77	108	3	116	343	1952
NWFP	1362	185	70	94	156	5	239	449	2559
Northern	2331	122	5	66	372	0	15	660	3572
A. Kash.	1284	110	40	58	73	5	65	255	1890
Baluchistan	1284	204	51	44	48	2	81	150	1868

TABLE VII. PERCENTAGE CONTRIBUTION OF EACH FOOD TO TOTAL NUTRIENTS

Areas	Cereals	Animal	Milk	Pulses	Veg.	Sugar	Oil	TOTAL
Pakistan	60	6	5	3	5	7	13	100
Rural	63	4	7	3	5	8	11	100
Urban	62	6	4	3	5	5	14	100
City	56	8	4	4	5	6	17	100
Punjab	58	4	7	3	6	7	14	100
Lahore	57	6	5	4	6	6	15	100
Sind	66	3	7	3	4	6	10	100
Karachi	55	9	3	4	6	6	18	100
NWFP	53	7	3	4	6	9	18	100
Northern	65	3	0	2	10	0	18	100
A. Kash.	68	6	2	3	4	3	13	100
Baluchistan	69	11	3	2	3	4	8	100

TABLE VIII. CALORIE INTAKE IN PAKISTAN

Population Group	Average Intake	Recommended Intake	Average % of Recommended	Percent Under 70% Recommended
Adult Male	2522	2900	87	32
Adult Female	2237	2100	107	18
Pregnant	2165	2500	87	28
Lactating	2298	3100	74	46
Boys 6-15 Yrs	1910	2200	87	28
Girls 6-15 Yrs	1814	2100	86	18
Boys 0-5 Yrs	1166	1300	90	34
Girls 0-5 Yrs	1169	1300	90	30
PRE-SCHOOL				
12-23 Months	1023	1000	102	28
24-35 Months	1069	1200	89	33
36-47 Months	1172	1300	90	33
48-60 Months	1314	1500	88	31

Food nutrients

The amount of food eaten is multiplied by the specific nutrient value for that food. Table 6 shows the amount of nutrient each food contributes. Table 7 shows the percentage contribution of the total. Throughout the country cereals are the major contributors to calories, proteins and iron [1].

For cereals calorie ranges from 53% to 69%

" " protein " " 58% " 73%

" " iron " " 69 " 80%

For calories, oils are the next most important contributor ranging from 7% to 18%. The observed and recommended calories for different ages and biological groups are shown in Table 8. It shows that our eating habits are not providing enough calories comparable to recommended intake. This gives an undernourished status to our country, demanding an improvement in diet intake.

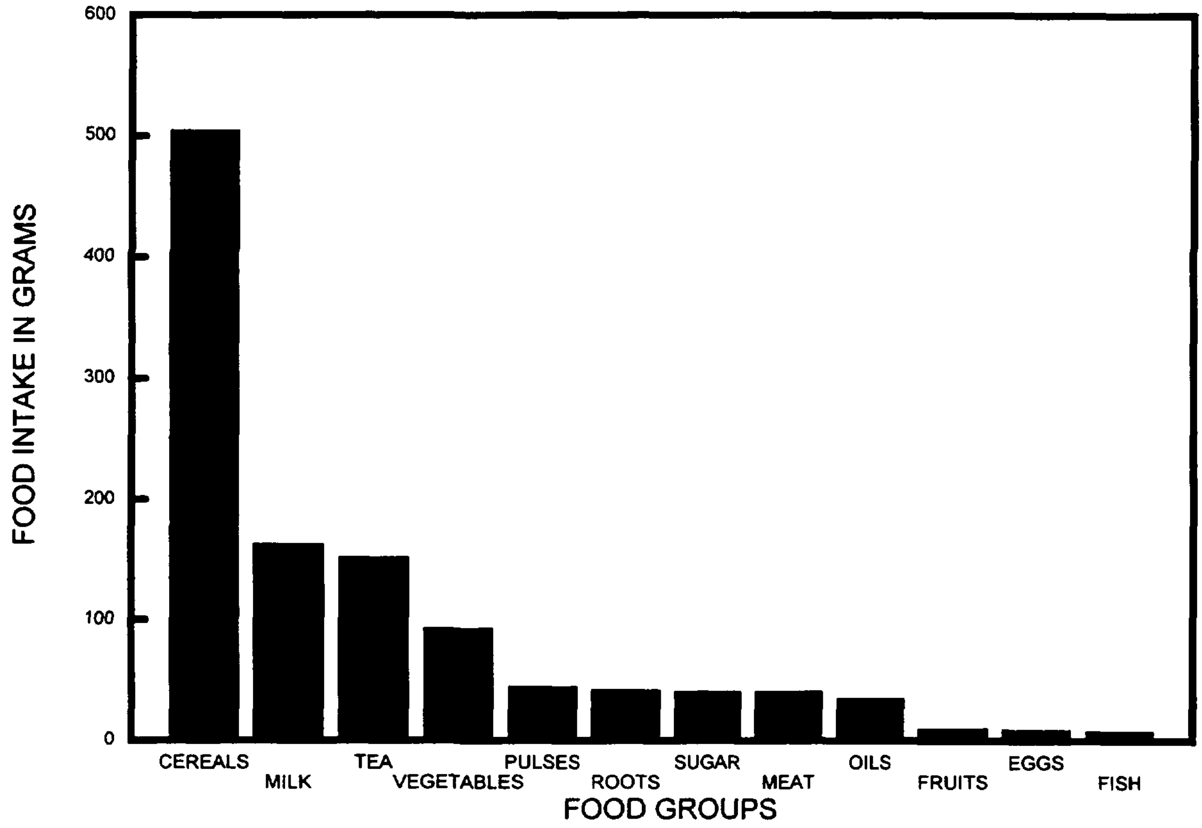

Fig.6 Amount of food eaten in grams/day/person

CONCLUSION

The height of adult reference Pakistani man and woman in the age range of 20-29 years was found to be 170.55 and 157.52 cm, respectively. The weights are 63.66 and 52.08 Kg and it would be appropriate to use these values. The ICRP Caucasian reference man and woman [2] are 170 & 160 cm tall, and weigh 70 & 58 Kg respectively. This shows that average height of Pakistani man is comparable to that of ICRP man in spite of the differences in socioeconomic and demographic background. Female height and the weight of both sexes are found to be comparatively lower than that of Caucasian population. In evaluating the impact of any environmental stress including radiation hazards on Pakistani population these newly established values may be used.

The food consumption status of reference Pakistani man/woman was found to be lower than the recommended values. It is hoped that in future, this baseline data will help to improve the social and nutritional status of our population. It is expected that these established estimates for physical characteristics and daily nutritional status of reference Pakistani man/woman will be useful for most purposes of planning for exposure at low levels.

ACKNOWLEDGEMENTS

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COMPILATION OF ANATOMICAL, PHYSIOLOGICAL AND DIETARY CHARACTERISTICS FOR A FILIPINO REFERENCE MAN

XA9846844

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Abstract

The Asian Reference Man is the study of the biological characteristics of the different ethnic populations in the Asian Region. Its aim is to update the existing International Reference Values called ICRP Reference Man which is used for the calculation of radiation exposure. The Philippines is a participant in the study of the formulation of the Asian Reference Man and is represented by the Philippine Nuclear Research Institute. The biological parameters included in the study are the physical, anatomical, physiological and the dietary characteristics representing the Filipino race and customs. The normal Filipino values were obtained from past nationwide and regional surveys, from medical records of private and government institutions and from random sampling of the population. Results of the study are presented in tabulations according to its gender and to its age group. Statistical analysis of the data are presented as the mean, standard deviation and the median using Microsoft Excel Software and Clipper Compiled Program.

INTRODUCTION

The Asian Reference Man was conceptualized when the International Commission on Radiation Protection (ICRP) recognized that substantial differences in the values of biological parameters exist between Caucasian and the Asian Man. Since sixty (60) percent of the world population come from Asian Region, the application of the Caucasian data for the calculation of internal and external radiation exposure for Asians may produce inaccurate results.

The differences in the anatomy, physiology, and metabolic characteristics between the Caucasian and the Asian has been earlier demonstrated by Tanaka et al [1]. Hence in 1988, the International Atomic Energy Agency (IAEA) organized a coordinated research programme on the compilation of physical, anatomical, physiological and metabolic characteristics for a Reference Asian Man. Twelve (12) IAEA member countries from the Asian Region joined this programme. The Philippines is represented by the Philippine Nuclear Research Institute (PNRI) with the task of collecting biological data specific to the average normal Filipino.

PHYSICAL PARAMETERS

The Filipino is defined to be a mixture of different races namely, Malay (40%), Indonesian (30%), Negrito (10%), Chinese (10%), Indian (5%), Arab (2%), and European or American (3%) [2]. The physical characteristics of an average Filipino are as follows [3,4]:

	MALE	*FEMALE*
Height, cm	163	151
Weight, Kg	56	49
Life Span, yrs	61.9	65.5
Sex Ratio, %	50.2	49.8

Table 1 shows the other observed values for the average weight of the Filipino male and female according to age group. Results indicate that at birth, the male is heavier than the female. However, at the age of ten years, the female weighs slightly more then the male. The male reached the maximum weight at age 30-39 years while, the female weight peaks at a later age (40-49 years).

Table 2 gives the growth rate of the average Filipino as a function of time. At the age of ten, the female has the tendency to increase body length while that of her male counterpart occurs at the age of fifteen years. The peak in the growth of the male Filipino is observed at 30-39 years. The female's maximum growth is shown at the age of 20-29 years.

The other somotological data measured in centimeters, for the Filipino man aged 20 to 50 years old are as follows:

	MALE	*FEMALE*
Sitting Height, cm	86.0	80.3
Chest Girth, cm	88.0	84.0
Chest Width, cm	38.0	35.0
Neck Girth, cm	43.0	37.5
Arm Length, cm	35.1	32.2

Sources of the above information were the Food and Nutrition Research Institute (FNRI) and the Bureau of Product Standards (BPS) [3,5,6].

Tables 3 to 6 show the growth rates for the somatological data such as, arm length, sitting height, chest girth and width, neck and head circumference for other age groups for both male and female [7-9]. The growth rates of these somotological data cease to increase at age 40.

ANATOMICAL PARAMETERS

The organ masses of the Filipino adult (20-50 years), expressed in grams, are as follows:

TABLE I. OBSERVED VALUES FOR THE WEIGHT OF THE FILIPINO

AGE	MALE			FEMALE		
	Number of People	Weight - kg		Number of People	Weight - kg	
		Mean	Std. Dev.		Mean	Std. Dev.
< 1 Year	156	7.5	1.2	169	7.0	3.1
1 Year	238	9.3	1.4	250	9.0	1.7
5 Years	236	15.2	1.7	236	15.2	1.7
10 Years	227	24.3	3.8	247	25.7	5.0
15 Years	208	43.1	7.6	227	43.3	6.2
20-29 Years	1,299	55.3	7.1	1,488	47.7	7.6
30-39 Years	913	58.0	8.8	1,079	50.4	8.9
40-49 Years	610	57.3	9.6	770	50.5	10.0
Total Adult, 20-49 Years	2,822	56.6	8.3	3,337	49.2	8.7

TABLE II. OBSERVED VALUES FOR THE HEIGHT OF THE FILIPINO

AGE	MALE			FEMALE		
	Number of People	Height - cm		Number of People	Height - cm	
		Mean	Std. Dev.		Mean	Std. Dev.
< 1 Year	156	68.1	3.6	167	66.4	4.0
1 Year	234	75.7	4.7	245	75.0	4.9
5 Years	253	102.9	6.4	236	102.6	5.6
10 Years	227	126.8	6.2	247	128.9	7.9
15 Years	208	155.1	8.2	227	149.8	5.9
20-29 Years	1,299	163.3	6.1	1,486	151.4	5.4
30-39 Years	913	164.2	22.6	1,079	151.4	5.3
40-49 Years	610	162.2	5.9	790	150.8	5.6
Total Adult, 20-49 Years	2,822	163.4	13.8	3,355	151.3	5.4

TABLE III. OBSERVED VALUES FOR THE ARM LENGTH OF THE FILIPINO

AGE	MALE			FEMALE		
	Number of People	Arm Length - cm		Number of People	Arm Length - cm	
		Mean	Std. Dev.		Mean	Std. Dev.
< 1 Year	156	13.8	1.1	169	13.3	1.1
1 Year	237	15.5	1.2	249	15.4	1.3
5 Years	253	21.0	1.5	235	20.8	1.4
10 Years	227	26.2	1.6	247	26.9	1.9
15 Years	208	32.7	2.2	227	31.5	1.8
20-29 Years	1,300	34.9	1.9	1,490	32.1	1.9
30-39 Years	913	35.3	2.2	1,079	32.2	1.8
40-49 Years	610	35.3	1.8	788	32.3	1.8
Total Adult, 20-49 Years	2,823	35.1	2.0	3,356	32.2	1.8

TABLE IV. OBSERVED VALUES FOR THE SITTING HEIGHT OF THE FILIPINO

AGE	MALE			FEMALE		
	Number of People	Sitting Height - cm		Number of People	Sitting Height - cm	
		Mean	Std. Dev.		Mean	Std. Dev.
< 1 Year	-	-	-	-	-	-
1 Year	-	-	-	-	-	-
5 Years	253	56.8	3.6	236	56.0	2.9
10 Years	227	66.9	3.4	247	67.8	3.8
15 Years	208	80.2	4.4	227	79.2	3.3
20-29 Years	1,308	85.9	4.1	1,491	80.4	3.5
30-39 Years	918	86.2	3.4	1,082	80.5	3.6
40-49 Years	615	85.7	3.5	790	79.7	4.7
Total Adult, 20-49 Years	2,841	86.0	3.8	3,363	80.3	3.9

TABLE V. OBSERVED VALUES FOR THE CHEST CIRCUMFERENCE AND CHEST WIDTH OF THE FILIPINO

Age	Number of People	Chest Circumference cm		Number of People	Chest Width (Posterior) cm	
		Male	Female		Male	Female
0-1 Year	8,546	38-51	38-51	8,546	-	-
2 Years	Male 11,933 Female 12,287	50	49	Male 11,933 Female 12,287	21	20
4 Years		54	53		23	22
6 Years		58	56		25	24
8 Years		62	60		27	26
10 Years		66	64		29	28
12 Years		70	67		30	29
14 Years	Male 8,350 Female 6,327	75	71	Male 8,350 Female 6,327	33	31
16 Years		80	76		35	33
18 Years		84	80		36	34
20 Years		88	84		38	35
≥ 20 Years	19,265	85-112	78-98			33-37

TABLE VI. OBSERVED VALUES FOR THE NECK AND HEAD CIRCUMFERENCE OF THE FILIPINO

Age	Number of People	Neck Circumference cm		Number of People	Head Circumference cm	
		Male	Female		Male	Female
0-1 Year	8,546	23-26	23-23	8,546	37-47	37-47
2 Years	Male 11,933 Female 12,287	27	26.0		-	-
4 Years		28	27.5		-	-
6 Years		30	29.0		-	-
8 Years		31	30.0		-	-
10 Years		32	31.5		-	-
12 Years		34	32.5		-	-
14 Years	Male 8,350 Female 6,327	36	34.4		-	-
16 Years		38	35.5		-	-
18 Years		40	36.5		-	-
20 Years		43	37.5		-	-
≥ 20 Years	12,024	-	35.5-39.5		-	-

ORGAN	MALE	FEMALE	ORGAN	MALE	FEMALE
Brain	1,387	1,321	Kidneys	295	293
Heart	334	288	Liver	1,472	1,361
Lungs	1049	864	Adrenals	17	25
Spleen	138	120	Thyroid	22	30
Pancreas	129	105	Gall Bladder	29	40

Sources of these information came from autopsies of medico legal cases from Baguio General Hospital (Northern Philippines), V. Sotto General Hospital (Southern Philippines), Santo Tomas University Hospital, Philippine Constabulary Crime Laboratory and National Bureau of Investigation (all in Metro Manila). The weights of the cadavers were not recorded due to the unavailability of weighing scales. The organs of all the subjects considered were visually examined for the absence of pathological conditions (inflammation, necrosis, atrophy and other degenerative appearances), and were measured using calibrated weighing scales. Most of the autopsies came from adults who died of sudden deaths due to crimes. The computation, evaluation and analysis of data were done using Microsoft Excel Version 4.

The weight of the organs from newborn to age 70 years are given in Table 7 for male and in Table 8 for the female. There were 1,191 male and 236 female autopsies submitted to the Philippine Nuclear Research Institute. The samples size for the newborn up to adolescent ages were small (N<20) for both genders and these samples came from Baguio General Hospital and the Santo Tomas University Hospital. This study observed that the organ masses for the male were higher than the female. Moreover, the values for individuals more than 50 years of age diminished values. The weights of the organs of the Filipino adult (20 - 50 years) were also observed to be smaller when compared to the Japanese adult [10]. This observation, however, may be due, at least in part, to the difference in sample sizes between the two studies considering that the Japanese study which spanned twenty years covers much larger population size.

PHYSIOLOGICAL MEASUREMENTS

The two basic physiological parameters included in this study are the Water Balance Studies (WBS) and the Pulmonary Function Tests (PFT). Available data for the Pulmonary Function Tests from medical sources such as routine medical examination and executive medical check-up were extracted from the files of the Pulmonary Medicine Section of the Philippine General Hospital, Lung Center of the Philippines and the Philippine Heart Center for Asia. Actual Pulmonary Function Tests were also conducted in 50 randomly selected subjects (20 - 45 years) using the body box (plethysmograph) of St. Lukes Medical Center.

Water Balance Studies which measures the liquid intake of an average Filipino and its corresponding urinary excretion, was also done in volunteers like students, hospital staff, and office workers of the Baguio General Hospital, Cebu Doctors Hospital, Philippine Heart Center and Santo Tomas University Hospital.

The average daily liquid intake of the adult male (20-50 years) is 3.379 liters while its corresponding rate of elimination is 1.306 liters per day. Observed values for the male and female are tabulated below. Comparison of these results with the data from India and the ICRP Man shows that the Filipino consumes more liquid than the ICRP model but less liquid

TABLE VII. MASS OF SELECTED ORGANS OF THE FILIPINO MALE - g

AVERAGE VALUES

Age Group (Y)	No. of People	Heart	Lungs		Spleen	Pancreas	Kidneys		Brain	Liver	Adrenal		Thyroid	Gall Bladder
			Rt.	Lt.			Rt.	Lt.			Rt.	Lt.		
<1	18	19	35	34	7	4	7	8	1,020	89	2	-	8	5
1-2	5	62	113	103	47	25	38	38	1,125	364	-	-	-	5
3-4	5	86	133	124	50	37	53	60	1,250	681	-	-	-	-
5-6	3	97	138	143	66	49	72	74	1,283	735	-	-	-	10
7-8	5	139	239	219	77	61	84	88	1,300	922	-	-	-	-
9-10	9	166	266	249	88	70	95	98	1,317	1.064	10	10	10	-
11-12	5	191	335	316	92	89	98	103	1,350	1,140	-	-	-	-
13-14	0	-	-	-	-	-	-	-	-	-	-	-	-	-
15-16	9	306	425	406	124	100	131	138	1,357	1,299	-	-	-	-
17-18	18	311	476	456	128	110	137	146	1,362	1,438	15	10	15	20
19-20	81	323	531	498	133	124	143	149	1,385	1,455	-	-	15	35
20-50	953	334	541	508	138	129	145	150	1,387	1,472	9	8	22	29
51-60	78	358	549	520	127	117	133	138	1,320	1,356	8	8	30	55
61-70	50	368	550	526	117	113	125	131	1,274	1,286	5	5	20	25
71-80	19	374	563	539	98	101	119	123	1,151	1,245	-	-	-	-

TABLE VII (CONTINUED). MASS OF SELECTED ORGANS OF THE FILIPINO MALE - g

MEDIAN VALUES

Age Group (Y)	No. of People	Heart	Lungs		Spleen	Pancreas	Kidneys		Brain	Liver	Adrenal		Thyroid	Gall Bladder
			Rt.	Lt.			Rt.	Lt.			Rt.	Lt.		
<1	18	15	26	25	5	3	4	5	1,020	70	-	9	5	-
1-2	5	62	113	105	47	25	40	39	1,150	325	-	-	5	-
3-4	5	86	130	125	50	35	54	60	1,250	670	-	-	-	-
5-6	3	100	130	150	66	50	70	72	1,250	740	-	-	10	-
7-8	5	135	242	220	75	60	80	90	1,250	900	-	-	-	-
9-10	9	170	266	250	90	70	95	100	1,250	1,000	10	10	-	-
11-12	5	195	356	340	90	90	100	100	1,350	1,100	-	-	-	-
13-14	0	-	-	-	-	-	-	-	-	-	-	-	-	-
15-16	9	303	425	400	123	100	128	138	1,325	1,300	-	-	-	-
17-18	18	310	485	460	128	110	135	149	1,350	1,425	10	15	20	-
19-20	81	320	510	480	133	125	145	150	1,380	1,460	-	15	35	-
20-50	953	325	540	500	144	126	150	150	1,400	1,450	9	20	20	-
51-60	78	350	550	520	125	115	125	140	1,300	1,345	8	30	55	-
61-70	50	400	550	520	120	117	125	125	1,250	1,275	5	20	25	-
71-80	19	350	550	520	100	100	125	125	1,200	1,215	-	-	-	-

TABLE VII (CONTINUED). MASS OF SELECTED ORGANS OF THE FILIPINO MALE - g

STANDARD DEVIATIONS

Age Group (Y)	No. of People	Heart	Lungs		Spleen	Pancreas	Kidneys		Brain	Liver	Adrenal		Thyroid	Gall Bladder
			Rt.	Lt.			Rt.	Lt.			Rt.	Lt.		
<1	18	11	17	17	7	4	7	7	0	58	-	-	-	-
1-2	5	6	6	12	2	4	8	9	83	100	-	-	-	-
3-4	5	3	3	9	1	5	8	5	45	109	-	-	-	-
5-6	3	5	5	17	1	1	10	4	85	27	-	-	-	-
7-8	5	10	10	12	3	7	8	4	105	27	-	-	-	-
9-10	9	11	11	14	7	8	12	11	120	106	-	-	-	-
11-12	5	14	14	38	3	6	14	12	71	102	-	-	-	-
13-14	0	-	-	-	-	-	-	-	-	-	-	-	-	-
15-16	9	11	93	102	3	2	9	7	121	285	-	-	-	-
17-18	18	13	100	91	2	8	11	10	148	268	5	-	5	-
19-20	81	32	81	79	9	11	18	19	106	195	-	-	5	15
20-50	953	62	70	69	18	15	16	16	143	232	5	4	10	18
51-60	78	63	62	55	8	12	19	18	134	224	2	3	8	5
61-70	50	65	58	60	10	25	19	16	186	200	-	-	-	15
71-80	19	59	51	53	25	8	10	11	102	156	-	-	-	-

TABLE VIII. MASS OF SELECTED ORGANS OF THE FILIPINO FEMALE - g

AVERAGE VALUES

Age Group (Y)	No. of People	Heart	Lungs		Spleen	Pancreas	Kidneys		Brain	Liver	Adrenal		Thyroid	Gall Bladder	Thymus
			Rt.	Lt.			Rt.	Lt.			Rt.	Lt.			
<1	10	15	33	31	7	4	6	7	-	66	3	2	2	-	-
1-2	5	58	106	85	33	24	34	34	1,027	390	-	-	5	-	60
3-4	3	70	131	119	50	28	42	43	1,233	492	-	-	-	2	-
5-6	1	94	162	156	65	42	55	62	1,250	600	-	-	-	-	-
7-8	2	128	187	190	73	55	67	72	1,275	803	-	-	-	-	-
9-10	3	156	223	208	75	63	83	85	1,282	875	-	-	20	20	-
11-12	3	181	293	273	80	70	94	96	1,293	1,002	-	-	-	-	-
13-14	2	200	370	355	107	89	110	114	1,310	1,250	-	-	-	-	-
15-16	2	248	375	360	110	97	119	121	1,330	1,265	-	-	-	-	-
17-18	10	261	376	359	115	103	127	131	1,343	1,318	-	-	30	40	-
19-20	15	265	427	407	119	109	129	135	1,351	1,355	-	-	-	-	-
20-50	154	288	443	421	120	105	143	150	1,321	1,361	14	11	30	40	-
51-60	19	314	404	383	98	96	120	126	1,151	1,243	8	5	20	23	-
61-70	12	333	329	315	98	97	118	122	1,142	1,168	-	-	-	-	-
71-80	9	335	337	286	92	92	112	115	1,072	1,144	-	-	-	-	-

TABLE VIII (CONTINUED). MASS OF SELECTED ORGANS OF THE FILIPINO FEMALE - g

MEDIAN VALUES

Age Group (Y)	No. of People	Heart	Lungs		Spleen	Pancreas	Kidneys		Brain	Liver	Adrenal		Thyroid	Gall Bladder	Thymus
			Rt.	Lt.			Rt.	Lt.			Rt.	Lt.			
<1	10	11	25	24	4	2	4	4	-	56	3	2	2	-	-
1-2	5	58	100	75	30	24	35	34	1,000	380	-	-	5	-	60
3-4	3	70	130	112	48	28	41	43	1,200	480	-	-	-	2	-
5-6	1	94	162	156	65	42	55	62	1,250	600	-	-	-	-	-
7-8	2	128	187	190	73	55	67	72	1,275	803	-	-	-	-	-
9-10	3	156	220	200	75	63	85	86	1,275	885	-	-	20	20	-
11-12	3	182	300	280	80	70	95	96	1,300	1,000	-	-	-	-	-
13-14	2	200	370	355	107	89	110	114	1,310	1,250	-	-	-	-	-
15-16	2	248	375	360	110	97	119	121	1,330	1,265	-	-	-	-	-
17-18	10	260	380	343	115	104	125	129	1,325	1,300	-	-	30	40	-
19-20	15	255	430	420	124	107	130	133	1,350	1,400	-	-	-	-	-
20-50	154	280	450	420	120	104	150	155	1,300	1,400	20	11	30	40	-
51-60	19	300	400	380	100	99	120	125	1,120	1,240	8	5	20	23	-
61-70	12	335	325	300	97	100	120	125	1,130	1,175	-	-	-	-	-
71-80	9	350	300	282	96	93	112	115	1,100	1,120	-	-	-	-	-

TABLE VIII (CONTINUED). MASS OF SELECTED ORGANS OF THE FILIPINO FEMALE - g

STANDARD DEVIATIONS

Age Group (Y)	No. of People	Heart	Lungs		Spleen	Pancreas	Kidneys		Brain	Liver	Adrenal		Thyroid	Gall Bladder	Thymus
			Rt.	Lt.			Rt.	Lt.			Rt.	Lt.			
<1	10	7	19	19	6	3	5	5	0	31	-	-	-	-	-
1-2	5	5	8	16	15	2	3	3	62	32	-	-	-	-	-
3-4	3	4	7	11	10	2	1	-	47	20	-	-	-	-	-
5-6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-8	2	3	2	10	3	3	3	2	25	48	-	-	-	-	-
9-10	3	5	21	23	4	1	6	5	29	18	-	-	-	-	-
11-12	3	4	25	17	4	7	1	1	74	84	-	-	-	-	-
13-14	2	-	10	5	7	4	10	9	30	150	-	-	-	-	-
15-16	2	8	25	20	-	2	1	1	30	15	-	-	-	-	-
17-18	10	13	23	45	10	2	6	6	125	73	-	-	-	-	-
19-20	15	21	26	26	9	8	20	19	70	109	-	-	-	-	-
20-50	154	43	41	40	14	5	24	22	115	180	8	9	8	7	-
51-60	19	41	26	32	14	7	6	6	64	136	3	-	-	17	-
61-70	12	28	66	66	10	5	9	8	42	63	-	-	-	-	-
71-80	9	61	76	68	12	5	5	5	63	136	-	-	-	-	-

than the Indian counterpart [11,12]. The daily urinary excretion rate of the average adult Filipino is equal to the Indian value but slightly less than the ICRP model [11,12].

	No. of People	Intake - liters/day		Daily Elimination liters/day
		Water	Other Liquids	
MALE	40	1.911	1.469	1.306
FEMALE	116	1.665	1.316	1.270

In the Pulmonary Function Tests conducted in this study, the total lung capacity, vital capacity, minute volume and the 8-hour working volume were determined. Classification for the levels of activity of the subjects were also considered. Hence, values for the resting, light and heavy type of activities are included. The resting activity value was taken from the result of the test using the plethysmograph. The light activity was measured by allowing the subject do a one minute exercise with the Wright's spirometer in his or her mouth and using the foot stool for climbing up and down. For the heavy activity, the exercise was extended for another minute. This procedure was suggested by the head of the Pulmonary Medicine Department of St. Lukes Medical Center.

Results of the 8-hour volume were computed using the one minute volume. Actual 8-hour working volume could not be done due to the unwillingness of the subject and the inconvenience this test would cause the subject. Thus the above mentioned experimental design to calculate light and heavy activity levels were applied as instructed by the head of the Pulmonary Medicine.

Results of the Pulmonary Function Tests taken from the files of the Philippine General Hospital, Lung Center of the Philippines and Philippine Heart Center For Asia, are summarized in Table 9 for the Total Lung Capacity and Table 10 for the Vital Capacity. The average values for the Total Lung Volume for the male adult is 5.40 liters and for the female, it is 4.4 liters (Table 9). Observed values for vital capacity are 3.78 and 2.66 liters for the adult male and female respectively (Table 10).

Computed values obtained from actual PFT (expressed in liters) conducted in 50 non smoking volunteer subjects performed at St. Lukes Medical Center using the body box are shown below:

	TOTAL LUNG CAPACITY liters	VITAL CAPACITY liters	MINUTE VOLUME liters			8-HR WORKING VOLUME liters		
			Resting	Light	Heavy	Resting	Light	Heavy
MALE	5 00	3 53	14 86	22 60	49 01	7,133	10,848	23,525
FEMALE	4 21	2 67	10 74	21 62	42 64	5,155	10,378	20,467

The above result does not significantly differ from observed values earlier obtained by Roa et. al., on the Ventilatory Function Tests conducted in 283 non-smoking normal adults below fifty years old. The same work was verified in 358 subjects in 1989 by Dr. E. Santos of the Lung Center of the Philippines [13,14]. However data for the minute volume as well as the 8-Hr working volume were not included in their published information. Comparison of the values obtained for the minute ventilation, showed higher figures than the ICRP Reference and Indian Values [11,12].

TABLE IX. OBSERVED VALUES FOR THE TOTAL LUNG CAPACITY OF THE FILIPINO

AGE	MALE				FEMALE			
	Number of People	Total Lung Capacity liters			Number of People	Total Lung Capacity liters		
		Mean	Median	Std. Dev.		Mean	Median	Std. Dev.
16-19 Years	2	5.95	5.95	0.61	1	3.85	3.85	-
20-50 Years	27	5.40	5.54	1.05	18	4.40	4.35	0.78
51-60 Years	12	5.47	5.49	0.61	2	4.03	4.03	0.71
61-70 Years	7	5.46	5.46	0.77	5	3.95	4.27	0.88
71-80 Years	1	5.45	5.45	-	0	-	-	-

TABLE X. OBSERVED VALUES FOR THE VITAL CAPACITY OF THE FILIPINO

AGE	MALE				FEMALE			
	Number of People	Vital Capacity - liters			Number of People	Vital Capacity - liters		
		Mean	Median	Std. Dev.		Mean	Median	Std. Dev.
< 10 Years	3	1.13	1.06	0.12	0	-	-	-
10-15 Years	8	3.04	3.27	0.70	14	2.49	2.50	0.37
16-19 Years	16	3.70	3.76	0.61	15	2.90	2.81	0.40
20-50 Years	586	3.78	3.81	0.58	425	2.66	2.62	0.50
51-60 Years	179	3.24	3.27	0.57	118	2.21	2.20	0.41
61-70 Years	114	3.02	2.87	0.49	89	2.06	2.02	0.43
71-80 Years	35	2.72	2.76	0.53	18	1.74	1.65	0.37
81-90 Years	5	2.56	2.83	0.45	4	1.84	1.75	0.49

DIETARY PARAMETERS

The Philippine Nuclear Research Institute conducted its own food consumption survey in nine regions of the Philippines. The survey with the total number of 1954 households, had the average sample size 0.042% per region.

Respondents were briefed thoroughly on how to fill up the questionnaire on the food consumption. The filled up questionnaire were verified for its validity. Food purchased as bunch, scoop, a glassful or other form of group were weighted in forms that they were bought. Estimated weights were based on the nearest description on the amount of purchased food.

These survey entries were coded and a file was assigned per province. Age grouping were from 21 to 40 years old. The Food Composition Table (FCT) of the Food and Nutrition Research Institute (FNRI) was utilized to determine the edible portion and the composition of some elements in food based on 100 gram edible part of the food sample [15]. The elements available for analysis were sodium, potassium, magnesium, iodine, zinc, copper, manganese, calcium, iron and phosphorous. For food intake, all categories identified by this research were considered. Food entries on the questionnaires that were not in the list of the local FCT, utilized other FCTs created from other countries. Still other food samples have no available information. Calculation of the mean, standard deviation and median values were performed using Clipper Compiled Program.

In addition to the above survey, radiochemical analysis of eight food samples taken from residents from the National Capital Region, were conducted at the National Institute of Radiological Sciences in Japan. Each food sample consists of three complete meals and 2 snacks for an adult Filipino (21-40 years).

Results of the one week food consumption survey conducted in 1954 households are given in Table 11. Computed values for the food consumed by an adult Filipino have shown to be higher than the consumption of an average person from China and from India except for the values obtained in cereals [16,17]. The amount of cereals eaten by the adult Filipino lies between the quantities consumed by the Chinese and the Indian adults. However, the results obtained from this survey, are lower than the quantities consumed by the Caucasian Man [12].

Results of the computed values for the elemental composition of the daily dietary intake of the average adult Filipino using the FCTs of FNRI and those published by other countries, are given in Table 12. The calculated values obtained for the Filipino man have been observed to be lower than the ICRP Reference Man Values [12]. Significant lower values were obtained for the elements, sodium and potassium (Figure 1a). Earlier published report by De Leon et. al. showed similar results [18].

The analytical values, expressed in milligrams, for all the twelve elements obtained from the analysis of the food samples sent to Japan are as follows:

Sodium	1,596	Phosphorous	460	Aluminum	2.48
Potassium	757	Iron	5.85	Strontium	1.04
Calcium	284	Zinc	5.02	Copper	0.82
Magnesium	123	Manganese	1.65	Barium	0.19

The above analytical values validate the calculated values for sodium and potassium earlier presented (Figure 1a). However, significant differences in the analytical and the calculated values for the remaining eight elements were observed (Figures 1a & 1b). The reason for the differences is due to the daily variation in food intake by every individual and

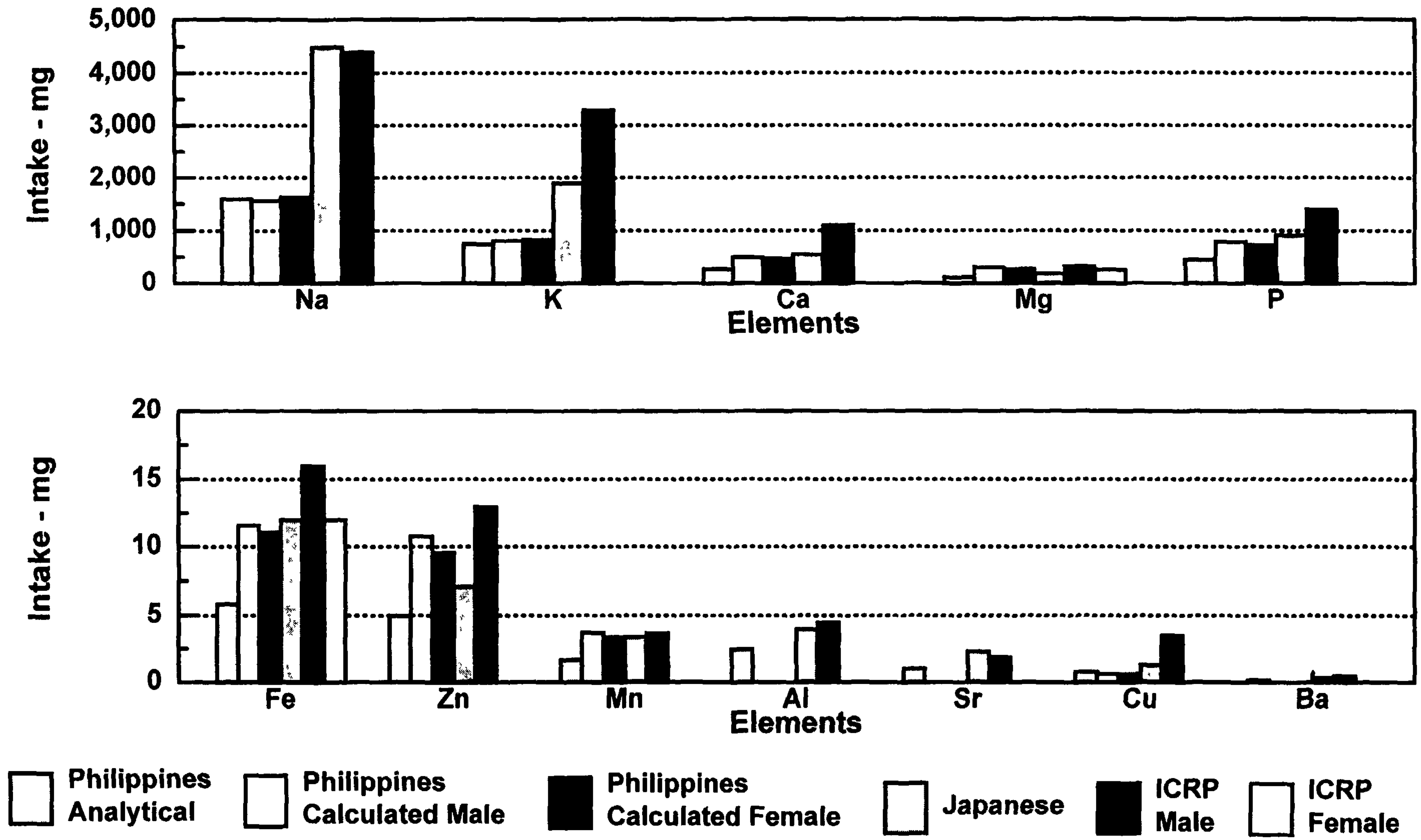

Figure 1 - Elemental Composition of Daily Dietary Intake

TABLE XI. DAILY NUTRITIONAL INTAKE FOR FILIPINOS

FOOD CONSUMPTION (GRAMS PER DAY)*			
	Mean	Median	Std. Dev.
Cereals	391 / 341	323 / 265	265 / 239
Nuts and Seeds	35 / 36	30 / 28	26 / 32
Pulses	56 / 55	49 / 45	41 / 46
Nuts, Seeds and Pulses	94 / 96	84 / 84	48 / 62
Potatoes and Starches	65 / 67	50 / 51	49 / 50
Sugars	31 / 26	25 / 23	26 / 20
Confectionaries	16 / 20	19 / 17	14 / 17
Sugars and Confectionaries	64 / 53	52 / 50	43 / 36
Fats and Oils	22 / 23	20 / 20	16 / 19
Fruits	113 / 114	101 / 100	71 / 77
Green and yellow vegetables	59 / 62	51 / 50	41 / 49
Other vegetables	41 / 40	31 / 30	33 / 34
Fungi	64 / 71	64 / 71	49 / 55
Total Vegetables	143 / 220	181 / 187	62 / 143
Algae	73 / 70	56 / 53	58 / 60
Fish and Shellfish	74 / 73	61 / 63	46 / 48
Meats	98 / 89	80 / 74	67 / 61
Eggs	31 / 32	28 / 26	20 / 22
Milk and Milk Products	9 / 10	7 / 8	8 / 10
Seasonings and Beverages	30 / 34	19 / 20	22 / 31

* Values are presented as: Male / Female

TABLE XII. ELEMENTAL COMPOSITION OF DAILY DIETARY INTAKE FOR FILIPINOS - mg*

	Mean	Minimum	Maximum
Calcium	502 / 482	27 / 15	4,109 / 4,908
Copper	0.63 / 0.62	0.06 / 0.02	2.57 / 4.55
Iodine	0.050 / 0.048	0.004 / 0.00	0.19 / 0.37
Iron	11.6 / 11.1	0.67 / 0.42	54.6 / 77.8
Magnesium	310 / 284	25.7 / 15.5	1,131 / 1,329
Manganese	3.73 / 3.40	0.25 / 0.17	14.9 / 23.2
Phosphorus	798 / 732	73.6 / 42.7	3,110 / 3,521
Potassium	815 / 837	36.2 / 20.8	8.225 / 5,541
Sodium	1570 / 1630	3.36 / 0.96	28,451 / 28,451
Zinc	10.8 / 9.6	0.79 / 0.59	43.3 / 41.4

* Values are presented as: Male / Female

the small sample size. The calculated values were taken from nine regions (1,954 households) surveyed while the analytical values came from only eight samples from the NCR.

SUMMARY

This study shows significant differences between the Filipino and the ICRP Reference Values. The variance in percent ICRP are as follows:

		FILIPINO	ICRP	% Difference
Physical	Height, cm	163	170	4.11
	Weight, kg	56	70	20.00
Anatomical	Kidneys, gm	295	310	4.84
	Liver, gm	1,472	1,800	18.22
	Spleen, gm	138	180	23.33
	Pancreas, gm	129	100	(29.00)
Physiological	Liquid Intake, l/day	3.38	2.65	(27.55)
	Liquid Elimination, l/day	1.3	1.4	7.14
	Vital Capacity, l	3.4	4.3	20.93
	Minute Volume, l	14.8	7.5	(97.33)
Dietary (U.S.A.)	Cereals, gm/day	391	207	(88.89)
	Meat, gm/day	98	206	52.42
	Egg, gm/day	31	47	34.04
	Fish, gm/day	74	22	(236.36)
	Milk, gm/day	9	508	98.22
	Fats and Oils, gm/day	22	49	55.10
	Sugar, gm/day	64	69	7.24
	Fruits, gm/day	113	184	38.58
	Vegetables, gm/day	143	202	29.20

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COMPILATION OF ANATOMICAL, PHYSIOLOGICAL AND METABOLIC CHARACTERISTICS FOR A REFERENCE VIETNAMESE MAN

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Abstract

In general, over the course of the time, the phenomenon of acceleration in physical development may be observed, i.e. the children and adults of the next generation are taller and heavier than in former generation. Our data presented in this paper show a regular trend of acceleration in the development on Vietnamese, but the trend is still slow and was mostly probably influenced by our difficulties in a long time of war. It is hoped that, the acceleration in the development may be increased in the future following the economical acceleration of our country, however it is known that the ratio between the length of different parts of human body is a specific characteristic for human race, sex and group age. Therefore we may estimate these ratio for the prolongation of the utilization of our measured physical data.

The result of studies on water balance of Vietnamese living in comfortable environment air temperature conditions and working in hot environment with different levels of energy expenditure and the elemental composition of sweat of workers in hot environment are also presented as well as the mass of major internal organs of Vietnamese.

The data of food consumption in Viet Nam National institute of Nutrition (1986) show an unbalanced state and deficient food intake in the nutrition of Vietnamese. However, after economical reconstruction in the last years the data of food consumption and food supply are varied. The quantity of protein, fat and milk products increase every time in people's food.

ASSESSMENT OF PHYSICAL MEASURES OF VIETNAMESE

In the compilation of anatomical, physiological and metabolic characteristics for a reference man, the height and weight of man's body are the basic data. These data are not only required for radiation protection, but will have application in other bio-medical sciences, particularly in the evaluation of public health and nutritional status of the people in each country [1].

Our data on the height and weight of Vietnamese are presented in Table 1. They show that the height of male and female adults 20-29 years old is greater than the height of adults in the 40-49 year age range. This acceleration in the development of the height in Vietnamese has been demonstrated by means of a **"horizontal observation"** - a comparison of the data observed in different group ages persons at the same time.

The Fig. 1 indicates the height of male and female Vietnamese in **"vertical observation"** - the comparison of other observed group - ages persons for other periods of time. The data presented in Fig. 1 show also an acceleration in the development of the height of Vietnamese.

Anthropologists have noted the phenomenon of acceleration of body development of a population, referred to as the *secular trend* [2]. The meaning of this term is that, over the course of time the children of the next generation are taller and heavier, and manifestations of puberty may appear earlier than in previous generations.

The rate of the secular trend varies for different populations in fixed time periods, and are the result of difference in nutrition and other environmental factors. For example: Fig. 2 shows the height of Japanese in 1985 [5] and Vietnamese measured in 1992. The data presented in Fig. 2 indicated that the average height of Japanese and Vietnamese females 30-39, 40-49, 50-59, 60-69 years old, and Japanese and Vietnamese males 50-59, 60-69 years

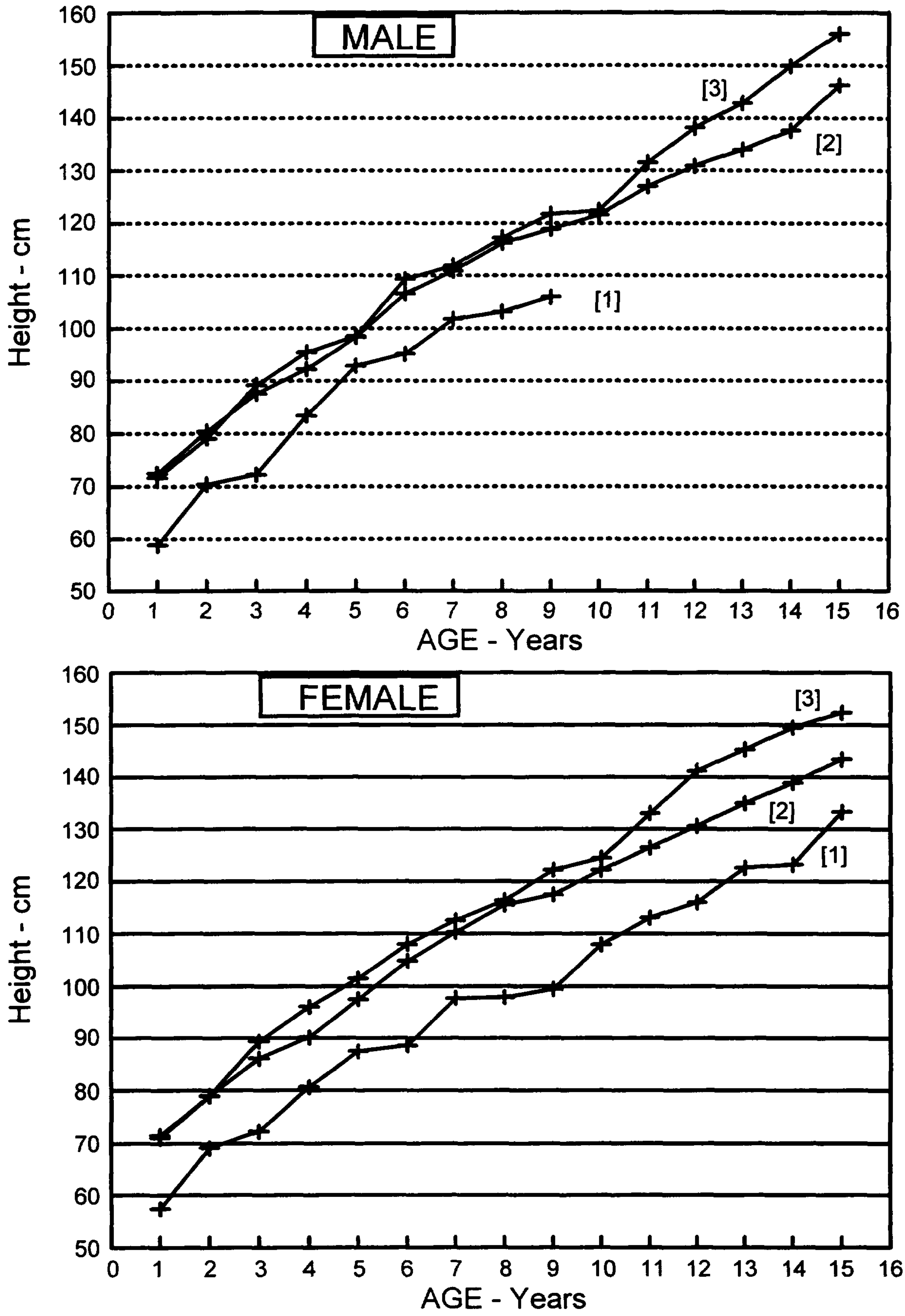
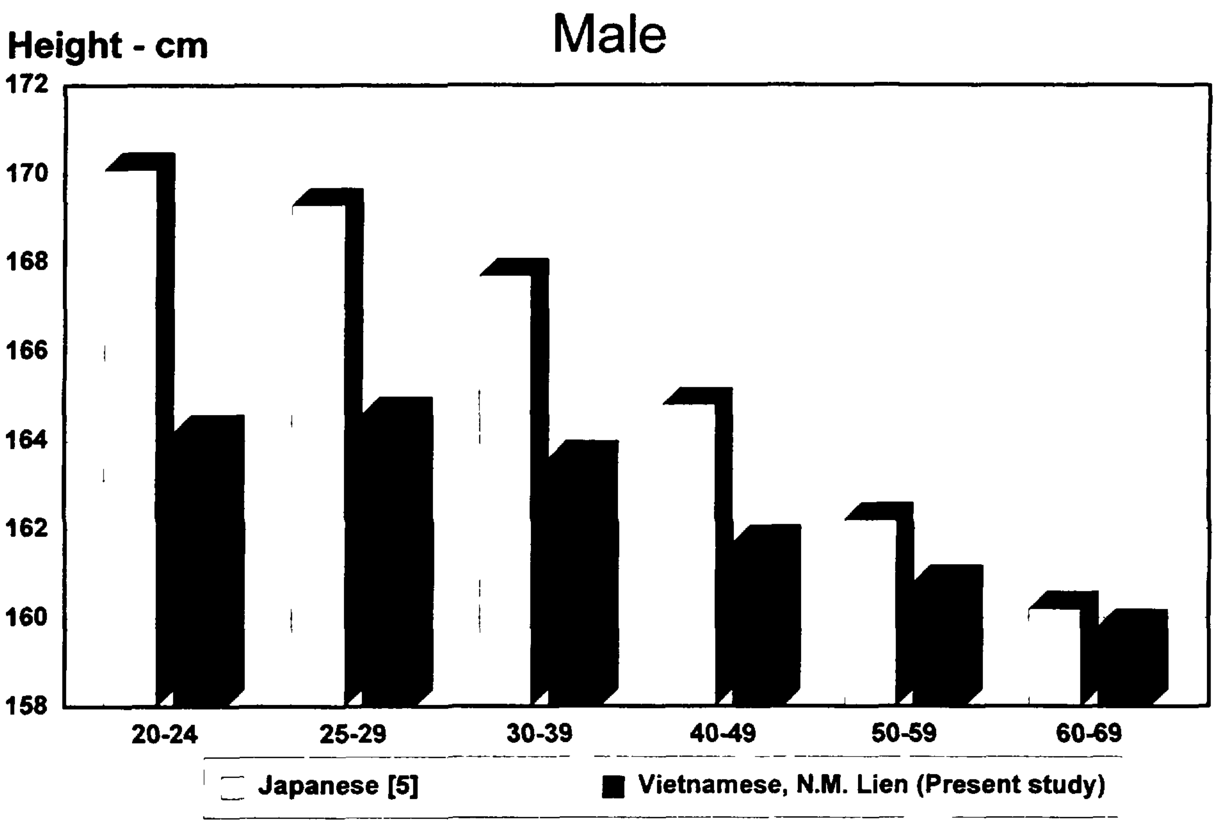


FIG. 1. Age dependent height from various studies.
1. Mondiere (1875) [3]; 2. Biol. Const. of Vietnamese (1975) [4];
3. Nguyen Manh Lien (Present Study).



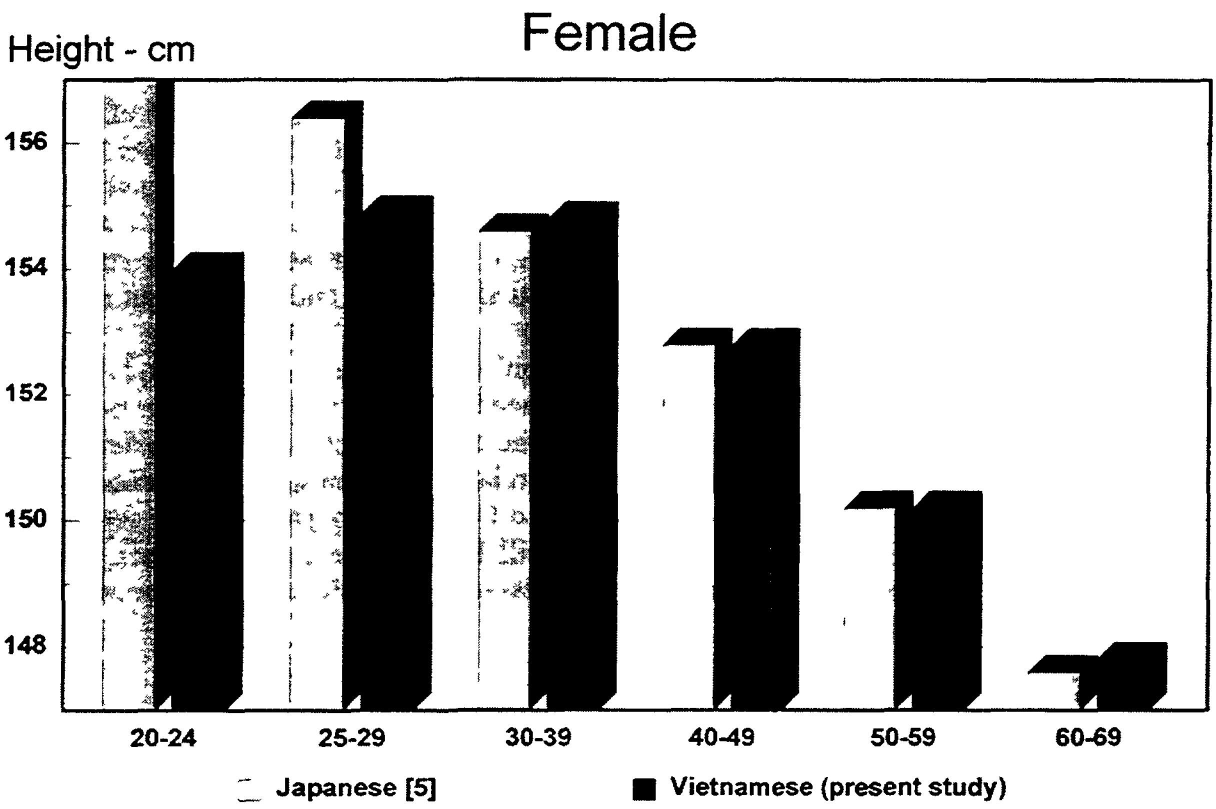


FIG. 2 Average height by age

old are nearly the same. However, the younger Japanese male and female are taller than young Vietnamese in the same age group. The height of Japanese has increased about (4-6) cm in 30 last years, compared with Vietnamese whose height has increased about (2-3) cm in the same period. The height of Japanese 19 years olds measured annually over a period from 1972 to 1982 shows an increase of about (4-5) cm (Fig. 3).

In the comparison of the secular trends in the Japanese and Vietnamese populations, the increase among the Vietnamese is still slow and was mostly probably influenced by our difficulties during a long period of war.

The development of anthropological parameters is the result of genetic as well of external factors [2]. The genetic factor gives the organism a determined potential for development while external factors, particularly the nutrition conditions supply the necessary material to allow the organism to reach its full development potential [6]. The data on food consumption of Japanese people presented in Table 2 may explain the increased rate growth in the Japanese in 30 last years [7]. The data in Table 2 suggests a parallel increase between the dietary content of protein, vitamins and minerals, and the growth trend in Japanese people over the last 30 years. Since the beginning of the economic reconstruction in Viet Nam, from 1988 to present time, the quantity of protein, fat and milk products in the people's food supply has increased. It is hoped that we will also see an increase in the development of Vietnamese people in the near future.

These results indicate an increase in the physical parameters of man with time. However the purpose of our research is to improve internal and external radiation dosimetry. This requires that we obtain the physical constants necessary to establish a dosimetric model for the Vietnamese population similar to the MIRD model [8]. To accomplish this, we can systematically survey the physical parameters of the population annually. This requires considerable time and an adequate number of personal for the measurements. It is not really economical. Therefore, we are seeking a second way to resolve the problem.

In artistic anatomy the term "human canon" is the ratio between the length of different parts of human body and either the body height or height of the head. The *human canon* of adolescent Vietnamese 17-19 years old is presented in Table 3. Following development of our preliminary data (Table 3), we believe that the body lengths and body circumferences may also be influenced the body weight. However, the experience of artistic anatomy shows that there is an intimate relationship between body weight and height, and the "human canon" is specific for each population race, sex and age group.

We hope that, with the aid of the "human canon" coefficients, we can extend the utility of the physical parameter measurements because we need to survey only two parameters every year: population height and weight. With these two factors, other physical parameters can be determined by multiplication of the height and the related "human canon" coefficient. The application of coefficients "human canon" is presented in Fig. 4 and Table 4. The coefficients for the physical parameters presented in Table 4 will be different for each Asian country. However, they may be related if they can be expressed by coefficients of "human canon" characteristic of the Asian population.

ORGAN MEASUREMENTS

The data of major internal organ mass of Vietnamese are presented in Table 5. The following comments summarize our experience in obtaining these measurements:

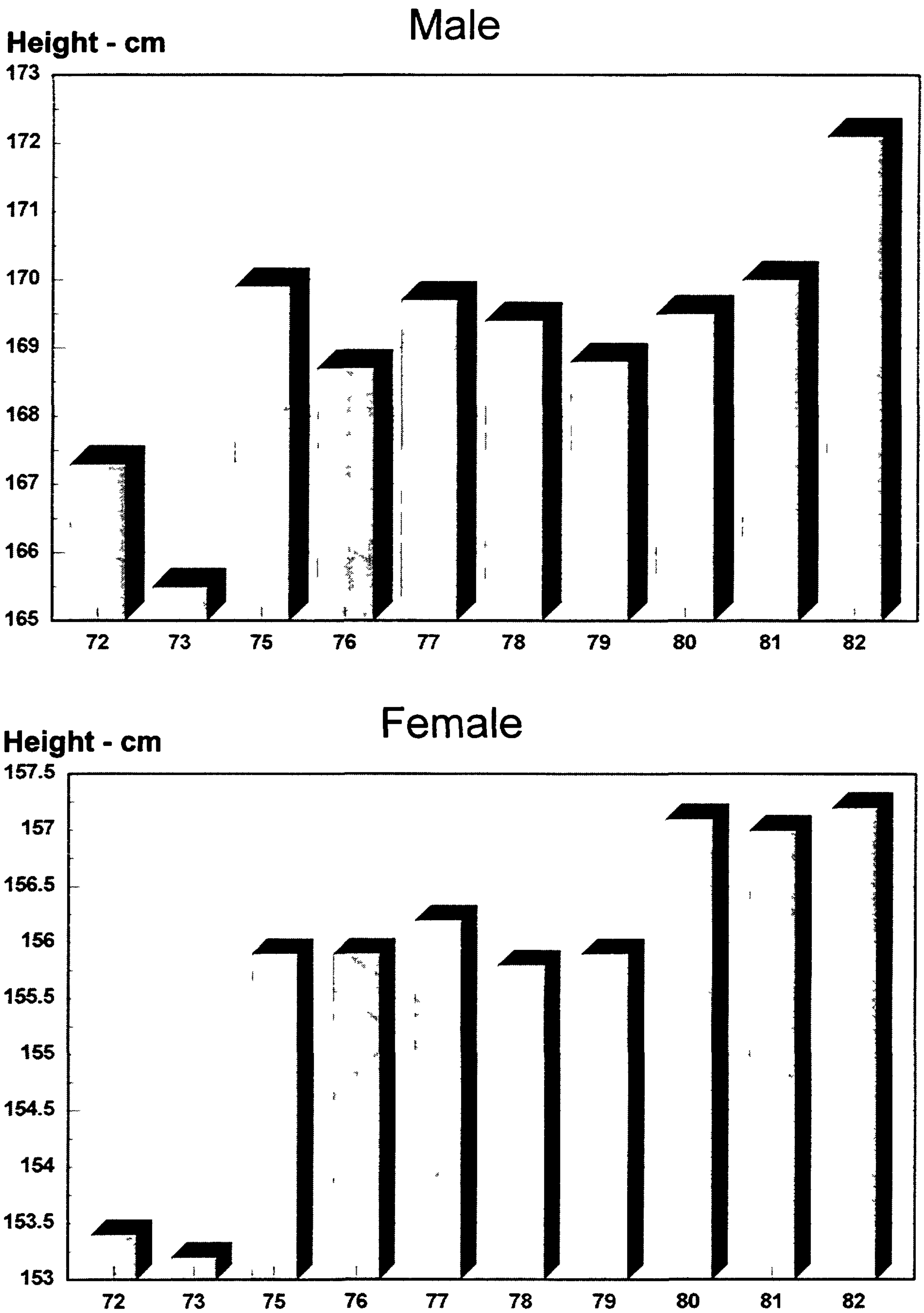


FIG 3 Average height of 19 year old Japanese

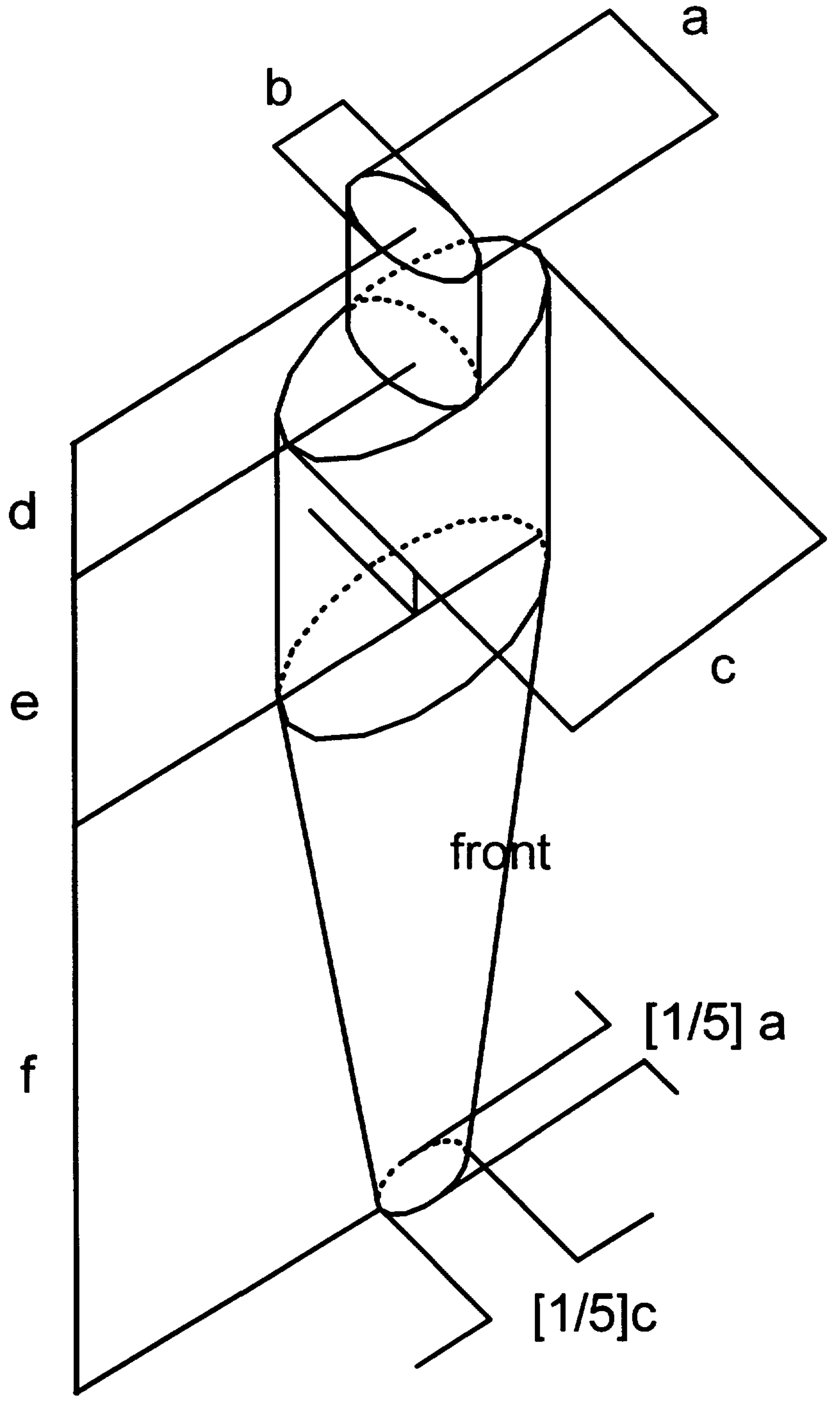


FIG. 4. MIRD Phantom parameters.

TABLE I. HEIGHT AND WEIGHT OF VIETNAMESE (MEASURED IN 1990-1993 VINATOM-IAEA)

Group ages	Males			Females		
	N	Height (cm)	Weight (kg)	N	Height (cm)	Weight (kg)
Newborn	776	48.55 ± 1.93	2.99 ± 0.37	715	48.53 ± 1.80	2.92 ± 0.36
1 year	421	71.58 ± 4.66	7.66 ± 0.29	390	71.47 ± 4.63	7.76 ± 0.28
5 years	812	98.53 ± 4.71	14.49 ± 3.09	734	101.45 ± 4.44	14.56 ± 3.06
10 years	412	122.41 ± 4.98	23.52 ± 3.09	431	124.49 ± 5.36	21.99 ± 2.93
15 years	616	155.99 ± 5.50	40.60 ± 5.72	477	152.32 ± 6.85	40.48 ± 5.10
20-29 years	3030	164.60 ± 4.89	51.52 ± 4.71	1690	154.53 ± 4.46	46.51 ± 5.57
30-39 years	902	163.66 ± 5.53	52.30 ± 5.72	785	153.60 ± 5.20	46.41 ± 5.57
40-49 years	682	162.08 ± 5.52	51.58 ± 7.06	622	152.59 ± 4.53	47.49 ± 6.43
Total adult 20-50 years	4614	164.04 ± 5.06	51.58 ± 5.25	309	153.90 ± 4.66	46.68 ± 5.34

TABLE II. CHANGE IN FOOD CONSUMPTION BY JAPANESE PEOPLE [7]

Categories	1960	1970	1980	1985
Rices	357.8	306.1	225.8	216.1
Wheat flour	64.2	64.8	91.8	91.3
Potatoes	54.1	37.8	63.4	63.2
Vegetables	163.5	249.3	251.4	261.7
Fruits	33.3	81.0	152.2	140.6
Fish & Shellfish	76.9	87.4	92.5	90.0
Meat	17.5	42.5	67.9	71.7
Eggs	20.6	41.2	37.7	40.3
Milk	31.3	68.4	107.8	116.7 (+ milk products)

TABLE III. THE AVERAGE "HUMAN CANON" OF VIETNAMESE ADOLESCENT 17-19 YEARS OLD

Physical Measures	Male		Female	
	In comparison with body height	In comparison with head height	In comparison with body height	In comparison with head height
Height	100.00	676.72	100.00	673.03
Head height	14.77	100.00	14.85	100.00
Sitting height	52.59	355.89	52.57	353.18
Chest circumference	50.29	340.37	53.02	356.91
Chest width	16.34	110.62	16.52	107.80
Chest depth	12.20	82.55	13.47	90.49
Head circumference	33.69	228.03	35.03	235.79
Neck circumference	20.48	138.65	20.82	140.16
Arm circumference	15.37	104.09	16.15	356.91
Thigh circumference	27.76	187.87	30.28	203.83
Forearm circumference	14.11	95.90	14.26	95.98
Shank circumference	19.30	132.26	20.59	138.59

Heart:

When opening the heart, usually we found the clots that form after death. Two basic types are seen: in the first, if the coagulation has occurred rapidly, producing soft uniformly dark red, moist masses. The second kind occurs when the erythrocytes have had time to sediment prior to coagulation. Above the cells, which form a clot similar to the first type, is a pale or bright yellow layer of resume and fibrin. The clots can be easily evacuated by a finger or a forceps, but not a stream of water. We found that the total quantity of the clots in the heart after death is normally 10 to 50 g.

The weight of the heart presented in Table 4 and 5 is the weight without of the clots. We think that in the "Reference Man", the weight of the heart can be estimated and, in addition, the average weight of the blood content in the heart in a cycle of heart's beating.

Lungs:

When the thorax is opened, air at atmospheric pressure replaces the negative pressure in the pleural cavity which has maintained with the expansion of the lungs during life, and causes them to collapse. They appear smaller than they would have in living man's body and no longer completely fill the pleural cavities. In Radiation Protection the weight of the lungs may be used as basic data in the estimation of organ dose, but their true dimensions during the life can be determined by other methods such as measurement of thoracic cavity, pulmonary radiography, measurement of respiratory volumes, etc.

Brain:

The brain's tissue is soft. As one opens the cranium, the brain's dimensions may be deformed. They appear different than they would be living body. Therefore the estimation of true dimensions of the brain may be done by means of craniometry and radiography.

Gastrointestinal system:

The weight and length of the components of gastrointestinal system can be estimated, with their contents, by anatomical measurement and physiological experience.

With regard to the data we have presented, we think that the weight of size of some internal organs such as the heart, lungs, etc. after autopsy may be different than they would be in the living body. The true value of these organs may be estimated through a combination of anatomical, physiological, ultrasound and radiological studies. The weight and size of other organs such as the liver, pancreas, spleen, etc. at autopsy may be similar their true values in the living body.

TABLE IV. MIRD PHANTOM MODEL OF VIETNAMESE (20-29 YEARS OLD)

Parameters	Male			Female		
	N	Mean ± SD	Coefficient "Human Canon"	N	Mean ± SD	Coefficient "Human Canon"
Height (cm)	3030	164.60 ± 4.89	100.00 ± 2.97	1690	154.53 ± 4.46	100.00 ± 2.88
Weight (kg)	3030	51.52 ± 4.71	-	1690	46.51 ± 4.85	-
Chest circumference	3030	82.49 ± 4.74	50.40 ± 2.87	1690	81.89 ± 4.20	52.99 ± 2.71
Sitting height (cm)	3030	86.49 ± 4.68	52.54 ± 2.84	1690	81.15 ± 4.27	52.51 ± 2.76
Phantom factors (cm)						
a	150	18.97 ± 0.67	11.52 ± 0.40	150	17.98 ± 0.75	11.63 ± 0.48
b	150	15.95 ± 0.50	9.69 ± 0.30	150	15.30 ± 0.56	9.90 ± 0.19
c	150	40.10 ± 1.42	24.36 ± 0.86	150	36.97 ± 2.11	23.92 ± 1.36
d	150	24.69 ± 1.76	15.00 ± 1.06	150	23.00 ± 1.91	14.88 ± 1.23
e	150	64.61 ± 2.43	39.25 ± 1.47	150	61.60 ± 2.55	39.86 ± 1.65
f	150	75.10 ± 3.72	45.62 ± 2.26	150	70.25 ± 3.68	45.46 ± 2.38

TABLE V. AVERAGE INTERNAL ORGAN WEIGHT OF VIETNAMESE

Organ		Group Ages											
		N	Newborn	N	1 year	N	5 years	N	10 years	N	15 years	N	Total Adult
a. Brain	male	32	355.63 ± 22.07	25	901.20 ± 67.84	25	1157.60 ± 77.74	28	1170.71 ± 77.36	27	1294.07 ± 80.59	78	1320.90 ± 79.70
	female	35	355.57 ± 24.17	26	900.00 ± 58.31	25	1123.20 ± 74.54	27	1138.89 ± 72.50	29	1243.10 ± 78.93	63	1284.13 ± 71.79
b. Breast (right)	female	10	8.20 ± 2.20	11	11.73 ± 3.47	15	17.13 ± 4.22	15	25.93 ± 7.67	16	120.63 ± 27.68	36	249.72 ± 45.43
c. Heart	male	32	17.09 ± 1.70	25	41.40 ± 2.89	25	82.44 ± 5.14	28	125.64 ± 7.61	27	203.93 ± 17.29	78	258.41 ± 25.82
	female	35	17.00 ± 1.97	26	42.00 ± 3.01	25	84.08 ± 5.17	27	119.81 ± 7.66	29	202.34 ± 18.56	63	230.24 ± 24.21
d. Kidney (both)	male	32	27.41 ± 2.78	25	72.04 ± 6.26	25	129.76 ± 11.48	28	194.00 ± 12.21	27	236.37 ± 13.68	78	296.23 ± 13.33
	female	35	26.00 ± 2.20	26	70.00 ± 6.40	25	128.20 ± 9.98	27	186.60 ± 10.75	29	234.10 ± 10.13	63	276.40 ± 12.67
e. Liver	male	32	75.88 ± 5.60	25	210.96 ± 16.82	25	402.80 ± 55.64	28	705.06 ± 76.71	27	1204.44 ± 107.89	78	1417.82 ± 116.91
	female	35	77.60 ± 5.41	26	221.20 ± 65.03	25	362.00 ± 32.72	27	692.20 ± 57.67	29	1161.90 ± 237.58	63	1319.00 ± 105.70
f. Lung (both)	male	32	39.91 ± 4.41	25	120.60 ± 12.52	25	212.24 ± 15.86	28	390.18 ± 19.79	27	643.70 ± 22.37	78	680.06 ± 27.30
	female	35	39.11 ± 4.02	26	119.80 ± 26.71	25	207.20 ± 20.52	27	325.40 ± 20.80	29	570.30 ± 21.17	63	607.50 ± 26.41
g. Ovaries (both)	female	24	0.25 ± 0.11	17	0.60 ± 0.24	25	1.51 ± 0.32	27	2.94 ± 0.51	29	5.19 ± 0.77	63	9.01 ± 1.04
h. Pancreas	male	32	5.53 ± 2.03	25	15.04 ± 4.30	25	40.00 ± 8.04	28	72.00 ± 12.06	27	102.00 ± 17.89	78	124.81 ± 21.55
	female	35	5.97 ± 1.42	26	14.12 ± 3.87	25	36.84 ± 6.31	27	69.81 ± 9.75	29	97.41 ± 21.16	63	110.30 ± 22.01
i. Pituitary gland	male	9	0.10 ± 0.01	11	0.14 ± 0.01	15	0.25 ± 0.05	15	0.34 ± 0.09	17	0.48 ± 0.14	78	0.60 ± 0.12
	female	10	0.11 ± 0.02	11	0.15 ± 0.02	15	0.25 ± 0.05	15	0.36 ± 0.06	16	0.55 ± 0.11	63	0.60 ± 0.11
j. Spleen	male	32	8.03 ± 1.33	25	25.88 ± 5.09	25	46.92 ± 12.01	28	87.92 ± 17.52	27	149.56 ± 28.64	78	165.74 ± 38.68
	female	35	8.03 ± 1.30	26	25.19 ± 6.40	25	41.76 ± 10.19	27	85.93 ± 19.16	29	137.24 ± 21.45	63	139.68 ± 26.71
k. Testes	male	35	0.35 ± 0.11	25	1.03 ± 0.52	25	2.96 ± 1.12	28	4.02 ± 1.72	27	17.6 ± 3.36	78	36.86 ± 4.44
l. Thymus	male	32	13.06 ± 2.19	25	20.00 ± 3.08	25	20.04 ± 3.63	28	15.00 ± 2.92	27	14.93 ± 3.15	78	10.00 ± 2.21
	female	35	11.97 ± 2.14	26	19.92 ± 3.05	25	18.08 ± 3.20	27	15.07 ± 3.04	29	14.97 ± 3.25	63	7.97 ± 2.23
m. Thyroid (L&F)	male	9	2.02 ± 0.27	11	2.95 ± 0.36	15	9.00 ± 1.50	15	20.03 ± 2.73	17	27.99 ± 3.42	78	35.47 ± 4.31
	female	10	2.17 ± 0.35	11	2.82 ± 0.32	15	9.23 ± 2.38	15	18.67 ± 3.02	16	27.75 ± 3.56	63	36.00 ± 3.31

PHYSIOLOGICAL DATA

Water balance of Vietnamese

The ICRP Reference Man (1975) [10] represents a population that typically lives in environmental conditions of temperature from 10°C to 20°C. However, the climate of Viet Nam is tropical, warm and humid. In Hanoi 277 days of every year, the average air temperature is higher 20°C. In Ho Chi Minh city, the daily air temperature is higher 25°C throughout the year. The hot environment influences to man's physiological functions such as caloric expenditure, water balance and others. Yas Kuno (1959) [11] shows that, at comfortable air temperatures, water loss by evaporation is passive process. When the air temperature increases above the threshold of skin's temperature, the sweat-glands will start to function, and perceptible perspiration occurs. The increase in sweating will result in increased in excretion of water, electrolytes, vitamins and other substances.

The water balance comprises the water intake and the water output. The water intake consists the fluid drunk and the water in the eaten food, and the water formed by the oxidation of carbohydrate, protein and fat (metabolic water). The output water consists the urine, the water in the faeces, and water evaporated from the skin and the lungs.

Methods

1. *Experimental Study on Water Balance*

Subjects: 6 male volunteers with an average age 36.8±3.0 years, an average total body weight 54.45±3.59 kg, an average height 160±4 cm. 6 women volunteers with an average age 35.0±2.0 years, an average total body weight 45.58±5.93 kg, and an average height 153±4cm. The volunteers worked in a laboratory at a level of light energy expenditure. The conditions were comfortable: air temperature, 22°C-26°C; relative humidity, 70%-85%. During the 3 day study the weight of food, water intake, urine and faeces were measured and recorded to the nearest gram. The total body weight was measured before and after each meal to the nearest 50 grams with a medical balance.

2. *Experimental Study on Elemental Composition of Sweat of Vietnamese Working in a Hot Environment*

The study involved 15 working male volunteers men-workers with an average age 20.7±1.16) years, average weight 53.70±4.26 kg and average height 164±3.8 cm. The volunteers have been in thermochamber under the following conditions:

Air temperature: 28.0±0.1°C and 35.0±0.1°C
Relative humidity: 80.0±2.5 %
Air velocity: 0.2 m/s

Volunteer exercised using the "steps test" with a energy expenditure of 52.21±2.00 w/h.

The total body weight loss was measured before and after each experience a by suspended balance to the nearest 10 grams. The samples of sweat collected from the hand have been determined by flame photometry and atomic absorption spectrophotometry.

3. Monitoring and surveillance study on loss of weight of workers

Evaluation of the working conditions included air temperature, humidity, air velocity and level of energy-expenditure. The weight of total body was measured before and after working time (generally 4 hours). The skin body's surface is calculated by means of Geigy monograms [10].

Results

Water balance

Results obtained from experimental study on physiological characteristics of subjects are presented in Table 6. The data presented in Table 7 show that the subjects did not experience heat strain.

The water balance data for the 12 volunteers are presented in Table 8. [The *Statistical error average* m = SD /√N.]

The daily consumption of boiled water and tea of Vietnamese is different than Caucasian. The high quantity of water content of solid food in Vietnamese meals is in boiled rice, vegetable broths, soups, ripe fruits, etc. The quantity of metabolic water of Vietnamese is also higher than those of Caucasian. Perhaps it is determined by the greater quantity of rice and vegetable consumed in daily meals.

In normal life, the intake of fluid is largely determined by social custom and habit. At this time, in Viet Nam, the people drink a small quantity of milk, which is used specially in the nutrition of children and patients. The majority of Vietnamese people also drinks a small quantity of alcohol or liquor in holidays, and don't drink other fluids such as wine and mineral water in daily meals. However, beer is used for thirst-quenching as is the tea and boiled water.

We know that the imperceptible water loss consists of the water evaporated from skin and lungs. The imperceptible weight loss consists of the imperceptible water loss and the deficit of weight in respiratory exchange of oxygen and carbonic gas [12]. The composition of the imperceptible weight loss of Vietnamese in comfortable conditions of environment and light energy expenditure are presented in Table 9. According to the data presented in Table 9, it is possible that the imperceptible weight loss of Vietnamese is approximately 30 g/m2 body's surface/hour. There is no difference between man and woman. However, when the air temperature becomes higher than the threshold of skin's temperature, the increase of sweating will occur and the loss of weight of total body becomes greater (Table 7).

The data presented in table 7 show that a person working with middle energy expenditure in hot environment may lose (2-3) kg per day by sweat. For rehydration he can take the same quantity of water. When the energy expenditure and the elevated air temperature increase the quantity of the water loss, water intake also increases to as much as 5 kg per day or more. The elemental composition of sweat of Vietnamese is presented in Table 10.

Pulmonary function

The pulmonary function of Vietnamese living in Hanoi and Ho Chi Minh city were carried out using an electronic spirometer "Fukuda Spiroshift - 3000". Data of respiratory air-flow-volumes were recorded and automatically analyzed by microcomputer (Tables 10 and 11).

It is known that the values of total lung capacity and vital capacity are related to basic variables such as sex, age, body height and mass. The dependence of vital capacity on these variables has been described by predictive equations of Knudson (1976, 1983) [13], ITS (Intermountain Thoracic society) (1979, 1981) [14], ECCS (European Community Coal and

Steel) (1961, 1967) [15], Kristufec P. et al... (1987) [16] and others. Our experience shows that the values of vital capacity for Vietnamese are similar to the values determined by predictive equations of Knudson (1983).

DAILY NUTRITIONAL INTAKE

The daily nutritional intake data are presented in Table 12, 13. The Elemental Composition of daily dietary intake presented in Table 15. From the data presented in Tables 13, 14, 15 there appears to be an increase in per capita food consumption in Viet Nam. The quantities of protein, including the protein from animal origin, and fat in food consumed are higher than the data observed in previous years. As a result of more industrialization in milk production, an increase of milk consumption in all Viet Nam had been observed in the first six month of this year (1993).

TABLE VI. PHYSIOLOGICAL CHARACTERISTICS OF SUBJECTS (AVERAGE DATA IN 3 EXPERIMENTAL DAYS)

No.	Physiological Characteristics	Males	Females
1	Food supply energy	(11.79 ± 0.54) MJ	(8.69 ± 0.52) MJ
2	Rectal temperature	(36.80 ± 0.05)°C	(36.80 ± 0.07)°C
3	Average skin temperature	(33.18 ± 0.12)°C	(33.42 ± 0.13)°C
4	Pulse	(77 ± 2) beats/mn	(77 ± 3) beats/mn

TABLE VII. LOSS OF WEIGHT OF VIETNAMESE IN DIFFERENT CONDITIONS OF WORK AND ENVIRONMENT

Conditions of work (N = number of subject)	Conditions of environment			Loss of weight (g/m^2 body surface/hour)
	Temperature (°C)	Relative humidity (%)	Air velocity (m/s)	
Work in laboratory (N = 12)	20-25	85	0.05 - 0.25	45
Conduction of tractor (N = 12)	37.6 ± 0.7	60	0.25 - 0.90	198 ± 15
Conduction of heavy cars (N = 18)	38.3 ± 0.7	60	0.05 - 0.09	145 ± 16
Conduction of machine elevators (N = 15)	35.9 ± 0.5	70	0.05 - 0.25	242 ± 20
Experience in temperature chamber with medium energy expenditure	25 35	80 80	0.25 0.25	135 ± 13 195 ± 15

The country wide milk intake data in Viet Nam during those 6 months are: 60 million boxes of condensed milk, 3 million boxes of dry milk and 1,6 million liters of sterilized milk. The total intake of these products is equivalent to 73,6 millions of litters sterilized milk, so that the mean daily intake of Vietnamese is 6,2 g of milk per day per capita.

The food consumption data from the Viet Nam National Institute of Nutrition (1986) show an unbalanced state and deficient food intake in the nutrition of Vietnamese. However, after economical reconstruction in the recent years the data of food consumption and food supply are varied. The quantities of protein, fat and milk products in people's food consumption continues to increase.

TABLE VIII. WATER BALANCE OF VIETNAMESE IN COMFORTABLE CONDITIONS OF ENVIRONMENT AND LIGHT ENERGY EXPENDITURE (AVERAGE DATA OF 6 MALE AND 6 FEMALE VOLUNTEERS IN 3 DAYS (x m) ml/24 h)

Contents of water balance	Man		Woman	
	Caucasian	Vietnamese	Caucasian	Vietnamese
Water intake:				
Milk	300		200	
Water drunk	150		100	
Other liquids drunk	1500		1100	
Total liquid drunk	1950	855 ± 58	1400	850 ± 36
Water content of solid food	700	1281 ± 39	450	1027 ± 39
Metabolic water	350	389 ± 20	250	262 ± 17
Total water intake	3000	2525 ± 41	2100	2139 ± 85
Water output	1400		1000	
Faecal water	100	155 ± 16	90	105 ± 33
Urine	850	1093 ± 89	600	849 ± 85
No perceptible water loss	650	1233 ± 84	410	1138 ± 83
Total water output	3000	2481 ± 86	2100	2092 ± 85
Water balance		+ 44		+ 47

TABLE IX. COMPOSITION OF IMPERCEPTIBLE WEIGHT LOSS OF VIETNAMESE WORKING WITH A LIGHT ENERGY EXPENDITURE IN COMFORTABLE CONDITIONS OF ENVIRONMENT (AVERAGE DATA OF 6 MALE AND 6 FEMALE VOLUNTEERS IN A 3 DAY TEST)

Contents	Quantity (g/m^2 body surface/h)
1. Water loss from skin	14-15
2. Water loss from alveolarly surface of lungs	10
3. Weight loss by respiratory exchange of oxygen and carbonic gas	5-6
Total	29-31

TABLE X. QUANTITY AND ELEMENTAL COMPOSITION OF SWEAT FROM 15 MALE VIETNAMESE VOLUNTEERS

Quantity and elemental composition of sweat	Air Conditions	
	28°C	35°C
Quantity of sweat (g/hour)	400 ± 13	581 ± 21
Elemental composition (mg/100 ml)		
Cl	95.90 - 192.50	196.00 - 323.75
Na	44.87 - 87.17	85.10 - 199.87
Ca	0.62 - 1.60	1.22 - 2.40
Mg	0.28 - 0.72	0.64 - 1.45
K	19.2 - 39.2	19.2 - 39.2
Cu	0.006	0.006
Mn	0.006	0.006
Fe	0.1 - 0.2	0.1 - 0.2

TABLE XI. TOTAL LUNG AND VITAL CAPACITY OF VIETNAMESE ($\bar{X}$ ± sd)l

Group Ages	Male			Female		
	N	Total lung capacity	Vital capacity	N	Total lung capacity	Vital capacity
5 years	115	0.75 ± 0.18	0.62 ± 0.15	115	0.62 ± 0.18	0.52 ± 0.15
10 years	115	1.93 ± 0.30	1.59 ± 0.25	115	1.74 ± 0.24	1.45 ± 0.20
15 years	115	3.74 ± 0.48	3.07 ± 0.40	115	3.20 ± 0.33	2.66 ± 0.28
20-29 years	132	4.53 ± 0.54	3.72 ± 0.45	98	3.54 ± 0.38	2.95 ± 0.32
30-39 years	120	4.40 ± 0.82	3.61 ± 0.68	96	3.30 ± 0.58	2.75 ± 0.49
40-49 years	105	4.08 ± 0.78	3.35 ± 0.64	90	2.97 ± 0.68	2.48 ± 0.57
Total Adult 20-50 years	357	4.43 ± 0.70	3.63 ± 0.58	284	3.28 ± 0.54	2.73 ± 0.45

TABLE XII. MINUTE VOLUME AND 8h WORKING VOLUME RESPIRATORY AIR OF VIETNAMESE

Sex	Group Age	N	Minute volume (l/min)			N	8h working volume (liters)		
			Active Level				Active Level		
			Resting	Light	Heave		Resting	Light	Heavy
Male	Newborn	12	0.5						
	1 year	12	1.4						
	5 years	12	3.0	6.0	11.0	12	28800	72000	
	10 years	12	4.5	8.5	14.0	12	34560	81600	
	15 years	12	5.0	20.0	40.0	12	36600	192000	422400
	Total Adult 20-50 years	36	6.5	25.0	45.0	36	37440	204000	453600
Female	Newborn	12	0.5						
	1 year	12	1.4						
	5 years	12	3.0	6.0	11.0	12	28800	72600	
	10 years	12	4.5	8.5	14.0	12	34560	81660	
	15 years	12	5.0	20.0	35.0	12	36600	192000	369600
	Total Adult 20-50 years	36	6.0	20.0	40.0	36	34560	192000	422400

TABLE XIII AVERAGE FOOD CONSUMPTION (g/CAPITA/DAY) IN VIETNAM IN 1990-1991

Food	Rural Regions									Urban Regions		Average of all country
	1-North Mountain	2-North Midland	3-North Delta	4-Middle North	5-Middle Coastal	6-Middle Mountain	7-South Delta	8-South North Area	Average Data	9-Hanoi City	10-Ho Chi Minh City	
Rice	493 0	425 0	480 0	414 0	406 0	497 0	482 0	463 0	457 5	404	404 4	453 6
Other cereals	6 6	59 9	2 8	9 3	-	0 2	2 8	0 8	8 5	13 5	32 2	9 8
Potatoes	44 0	4 6	62 9	106 0	42 1	8 3	5 6	9 2	39 2	12	4 2	36 8
Sugar	0 0	0 0	0 5	0 1	0 4	3 3	0 5	0 2	0 4	1 4	8 9	0 9
Oil seeds	19 7	8 1	4 0	4 8	1 2	0 1	3 3	6 6	5 5	8 6	4 8	5 5
Sofa cake	8 3	19 5	2 0	0 8	0 9	-	2 4	15 0	4 7	29 6	10 3	5 4
Vegetables	265	245	259	186	106	189	125	200	186	213	223	183
Ripe fruits	-	-	1 0	0 6	1 5	14 8	1 7	2 4	1 7	5 8	16 7	2 6
Meat	27 8	17 6	10 7	14 2	13 0	24 2	15 4	27 7	16 8	67	49 4	19 4
Eggs	1 6	1 2	1 8	0 8	1 2	0 5	2 3	4 4	1 7	10 3	7 8	2 2
Fish	13 1	27 5	39 2	61 8	112 0	55 3	99 5	78 7	67 2	32 9	55 6	65 9
Milk	0 0	-	-	-	-	-	-	-	0 0	-	6 7	0 4
Grease and oil	5 0	3 6	2 6	1 6	3 7	0 4	2 2	4 0	2 8	7 4	10 3	3 3
Fish sauce	23 4	21 0	38 3	18 5	36 2	4 3	26 7	22 1	26 4	12 7	13 7	25 4
Number of investigated families	1620	360	5040	1440	1080	206	1080	1080	11906	740	143	12789
Population (x 1000)	5388	4681	9069	8568	6660	2485	14339	3737	54928	54928	1089	59186

TABLE XIV. CHARACTERISTICS AND NUTRITIVE VALUE OF DIET IN VIETNAM (CAPITA/DAY)

Nutritive value		Rural Regions									Urban Regions		Average of all country
		1-North Mountain	2-North Midland	3-North Delta	4-Middle North	5-Middle Coastal	6-Middle Mountain	7-South Delta	8-South North Area	Average Data	9-Hanoi City	10-Ho Chi Minh City	
Energy (Kcal)		2129	1928	1982	1822	1800	1974	1953	1937	1934	1898	1930	1932
Protein (g)	Total	58 8	56 7	55 6	53 0	61 8	65 6	65 2	64 8	59 9	62 4	55 0	59 7
	Animal	8 5	8 0	10 2	14 1	25 6	20 1	23 7	22 6	17 1	19 9	16 5	17 2
Lipids (g)	Total	21 1	18 7	12 3	12 9	15 1	11 8	13 3	18 3	14 8	30 7	27 6	15 8
	Vegetal	11 7	10 7	7 4	6 9	4 9	5 3	5 5	6 5	7 1	9 4	5 0	7 0
Glucid (g)		412	371	400	362	343	389	381	365	378	331	348	376
Mineral (mg)	Calcium	447	693	768	528	472	333	528	629	565	445	339	551
	Phosphorus	788	812	770	749	767	721	804	834	775	819	3396	916
	Iron	10 7	10 8	10 7	9 8	8 9	8 1	9 2	10 1	9 8	10 7	9 6	9 8
Vitamins (mg)	Carotene	3 12	5 05	4 00	2 11	1 89	4 05	1 93	3 41	2 90	3 10	3 14	2 90
Vitamin	A	0 054	0 01	0 074	0 042	0 014	0 005	0 02	0 025	0 044	0 068	0 043	0 065
	B1	0 87	0 56	0 75	0 69	0 60	0 65	0 65	0 74	0 70	0 97	0 58	0 70
	B2	0 40	0 57	0 39	0 37	0 24	0 32	0 25	0 32	0 30	0 44	0 60	0 51
	PP	12 0	10 7	9 68	8 98	8 82	9 88	9 03	9 2	9 5	10 9	8 3	9 5
	C	81 8	69 6	87 8	71 4	29 1	43 4	28 0	44 8	62 9	64 8	30 8	61 2
Percentage of energy from													
	Proteins	11 2	12 1	11 5	11 9	14 1	13 6	14 0	14 0	12 0	13 5	11 8	13 0
	Lipids	9 3	9 0	5 8	6 6	7 8	5 5	6 0	9 0	7 0	15 0	13 5	9 1
	Glucids	79 5	78 9	82 7	81 5	78 4	80 8	80 0	77 0	80 1	71 5	74 7	77 9

TABLE XV. ELEMENTAL COMPOSITION OF DAILY DIETARY INTAKE

Country: Vietnam Regions Sampled: 10 ecol. regions Population Studied: 59186 people Period of Study: 1990-1991			References: Tu Giay Vietnam National Institute of Nutrition Report 1990-1991	
	Mean	Minimum	Maximum	Units
Aluminum	4.5	2.5	6.5	mg
Calcium	551	420	751	mg
Chlorine	11,250	4,260	15,975	mg
Copper	1.2	0.8	1.4	mg
Iodine	0.15	0.05	0.30	mg
Iron	9.8	6.5	12.8	mg
Magnesium	370	225	450	mg
Manganese	4.2	3.6	4.9	mg
Phosphorus	916	720	1,250	mg
Potassium	2,100	1,800	3,500	mg
Sodium	6,020	1,610	8,050	mg
Strontium	2.3	1.8	2.8	µg
Zinc	7.5	6.2	9.1	mg

CONCLUSIONS

1. The comparison of the physical measurement data obtained in this study with earlier data from other authors, and the evaluation of our data for different age groups in each year shows a regular trend of acceleration in the development of Vietnamese, however this trend is still slower than that of other countries.

2. In Radiation protection for the full use of measured physical parameters to avoid impact of this variation over the course of time, we may employ specific ratios between the length of different parts of human body for race, sex and group ages.

3. The weight and size of many internal organs as the heart, lungs, etc. at autopsy may be different than they would be in living man body's organism. It may be necessary to employ a combination of anatomical, physiological, ultrasound and radiological techniques to determine the in-vivo values of these organs. The weight and size of other organs such as the liver, pancreas, and spleen at death autopsy may be similar their true values in living body.

4. The daily water intake of Vietnamese living and working in normal environmental conditions is different than Caucasian. The major part of water intake is the quantity of water content in the boiled rice and soups in Vietnamese meals.

5. In tropical environmental conditions a worker with medium energy expenditure may lose (2-3) kg body weight body and a considerable quantity of minerals per day by sweat. For rehydration he can take the same volumes of water per day and an adequate quantity of mineral salts.

6. The food consumption data from the Viet Nam National Institute of Nutrition (1986) show an unbalanced situation and deficient food intake in the nutrition of Vietnamese. However, after economic reconstruction in recent years the food consumption and food supply data are varied. The quantities of protein, fat and milk products in people's food consumption are continuing to increase.

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