



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 increase 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 %

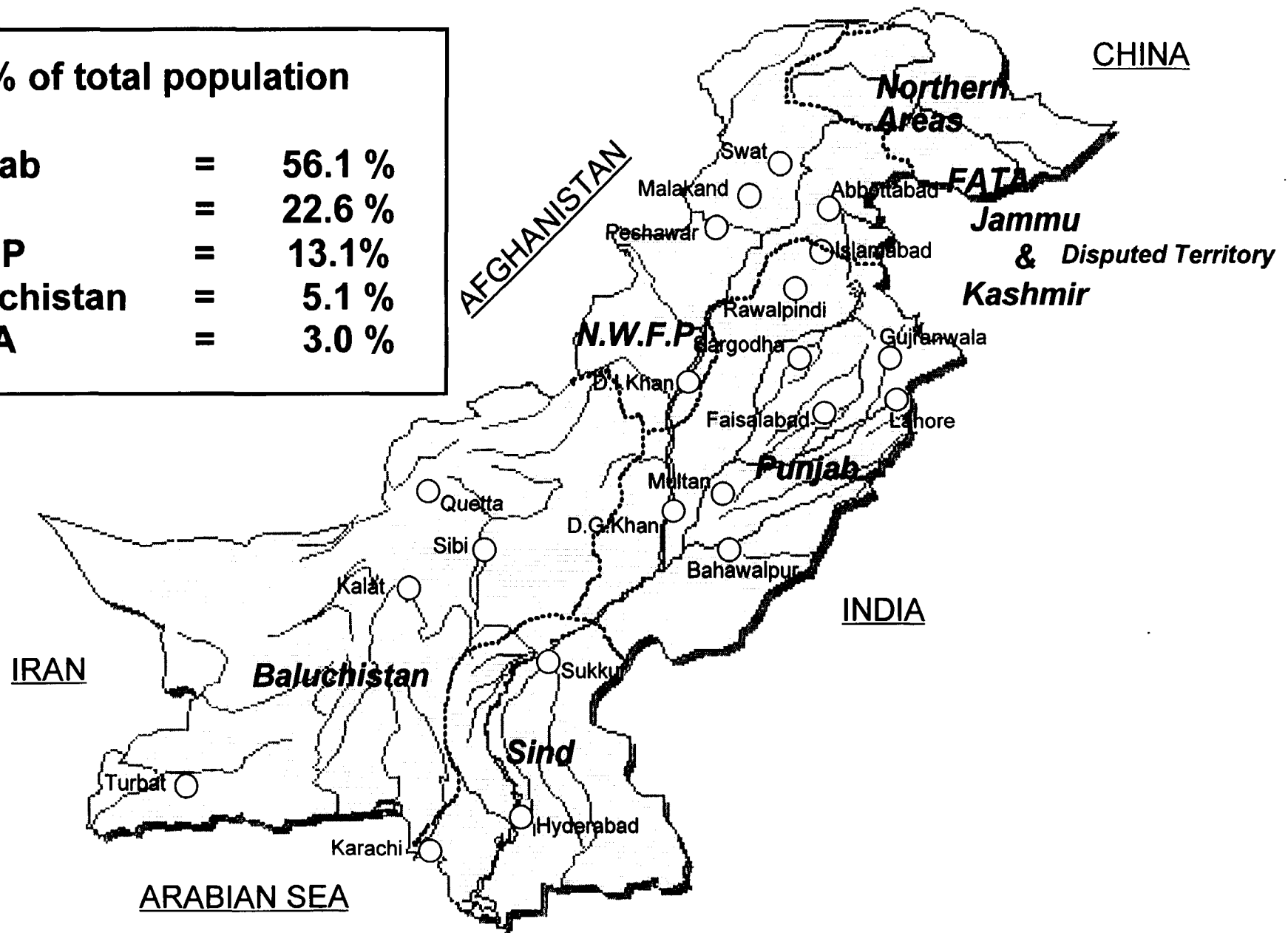


Fig. 1 Sample locations in Pakistan

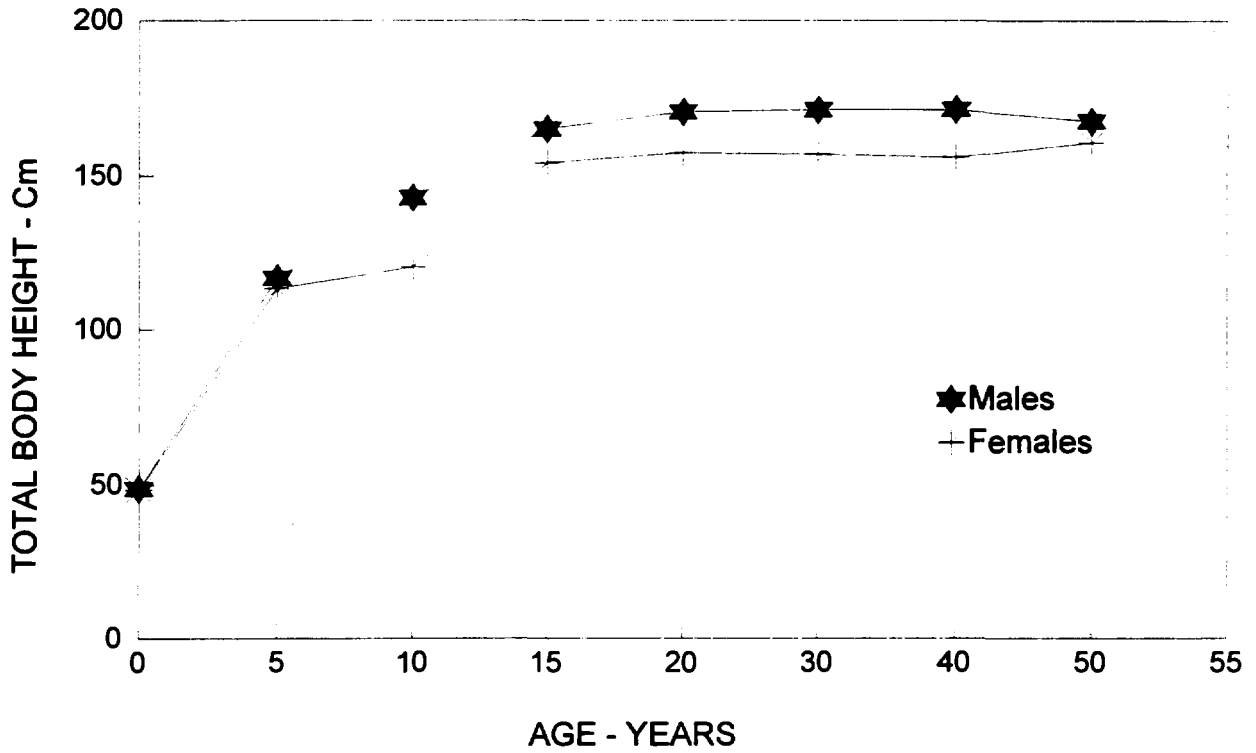


Fig. 2 Change in Body Height with Age

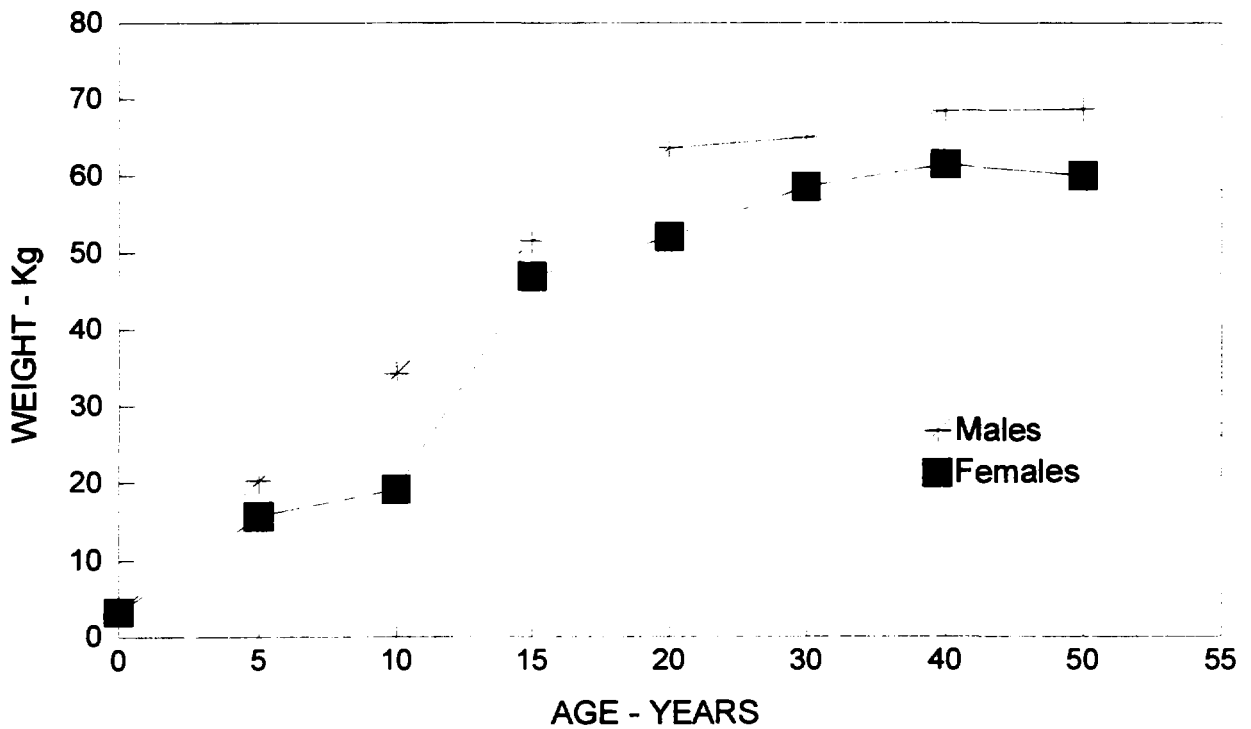


Fig. 3 Change in Body Weight with Age

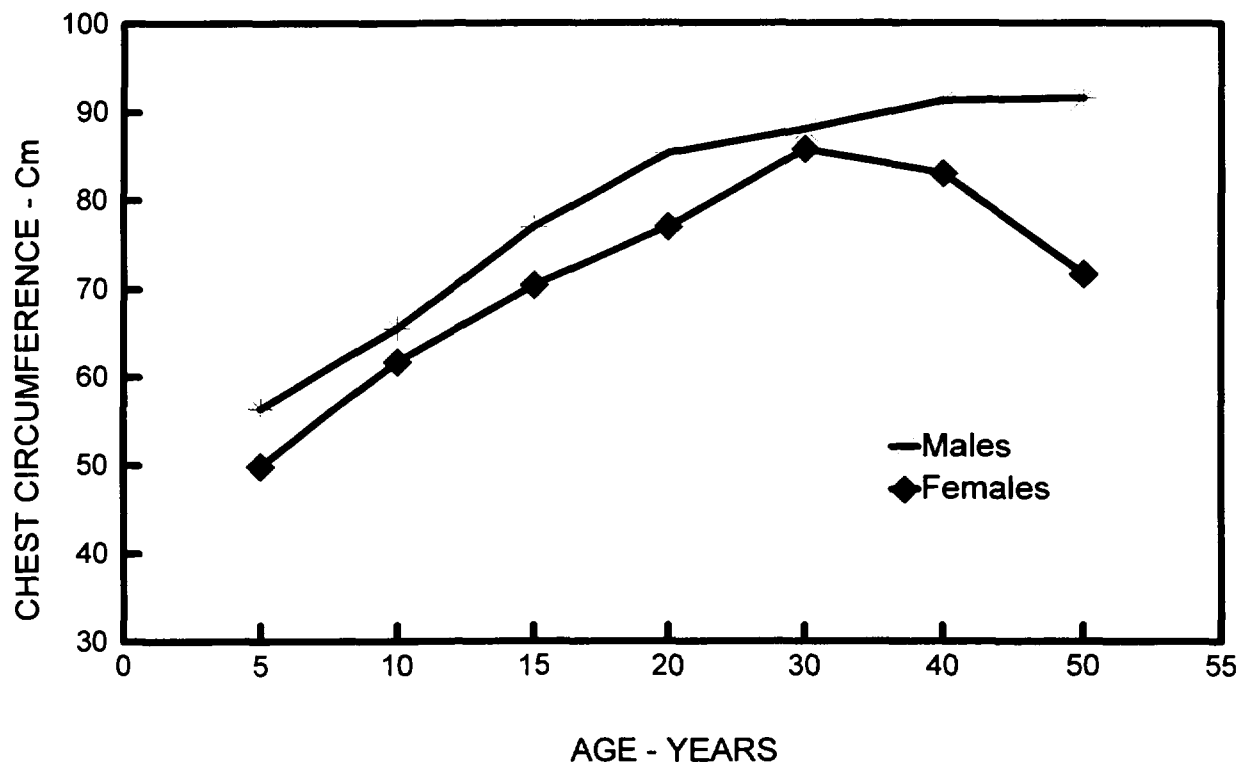


Fig. 4 Change in Chest Circumference with Age

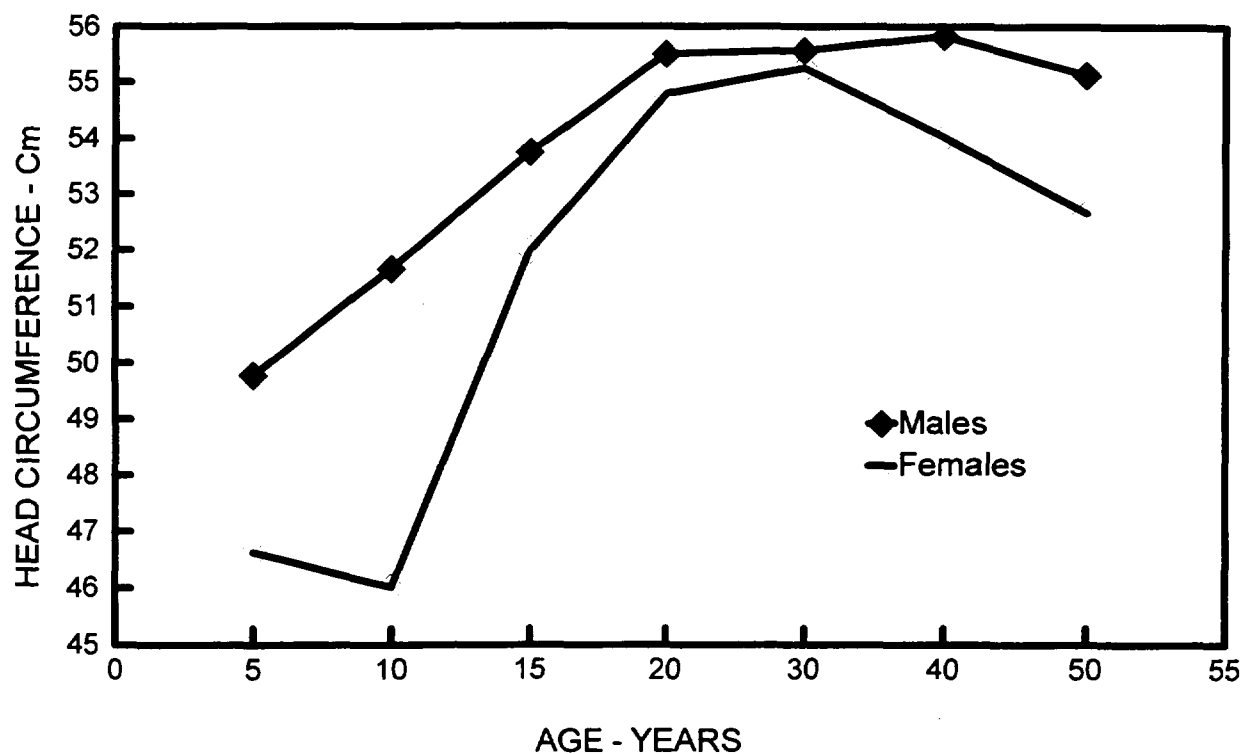


Fig. 5 Change in Head Circumference with Age

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		FEMALE	
			Height cm	Weight kg	Height cm	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.

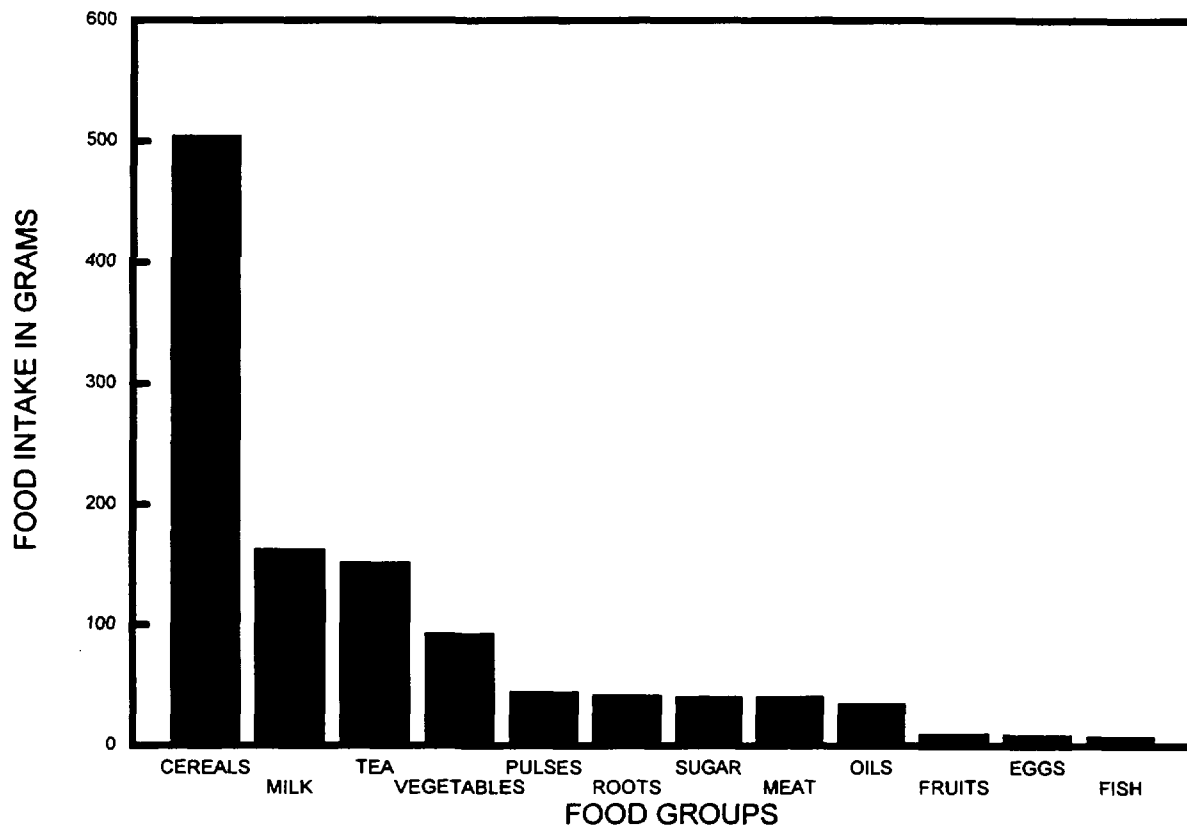


Fig.6 Amount of food eaten in grams/day/person

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.

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