IAEA-TECDOC-1005

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

Volume 1: Data summary and conclusions

Results of a co-ordinated research programme 1988–1993

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

The IAEA does not normally maintain stocks of reports in this series. However, microfiche copies of these reports can be obtained from

INIS Clearinghouse
International Atomic Energy Agency
Wagramerstrasse 5
P.O. Box 100
A-1400 Vienna, Austria

Orders should be accompanied by prepayment of Austrian Schillings 100,– in the form of a cheque or in the form of IAEA microfiche service coupons which may be ordered separately from the INIS Clearinghouse.

The originating Section of this publication in the IAEA was:

Radiation Safety Section
International Atomic Energy Agency
Wagramer Strasse 5
P.O. Box 100
A-1400 Vienna, Austria

COMPILATION OF ANATOMICAL, PHYSIOLOGICAL AND
METABOLIC CHARACTERISTICS FOR A REFERENCE ASIAN MAN
VOLUME 1: DATA SUMMARY AND CONCLUSIONS

IAEA, VIENNA, 1998
IAEA-TECDOC-1005
ISSN 1011-4289

Printed by the IAEA in Austria
February 1998

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

In preparing this publication for press, staff of the IAEA have made up the pages from the original manuscripts as submitted by the authors. The views expressed do not necessarily reflect those of the IAEA, the governments of the nominating Member States or the nominating organizations.

Throughout the text names of Member States are retained as they were when the text was compiled.

The use of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries.

The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the IAEA.

The authors are responsible for having obtained the necessary permission for the IAEA to reproduce, translate or use material from sources already protected by copyrights.

CONTENTS

1. INTRODUCTION

The establishment of guidance and limits for radiation protection purposes requires extensive data about the human. Development of secondary standards — the measurable quantities that are used to determine compliance with the primary limits — depend on knowledge or assumptions about the anatomical, physiological, and metabolic characteristics of the population to be protected. Moreover, decisions regarding proper actions to be taken to assure proper protection, such as control of food stuffs, necessitates population specific information regarding dietary factors such as food group composition and trace element content.

The International Commission on Radiological Protection (ICRP) has published a compilation of anatomical values, gross and elemental contents and physiological data for a Reference Man in Publication 23 [1]. They are currently developing a revised set of data to include more recent information. However, even the most recent work is heavily dependent on studies of European and North American populations.

The IAEA/RCA Co-ordinated Research Programme (CRP) on Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man[1] was initiated to obtain country and region specific data on Asian populations. Member States of the Regional Co-operative Agreement (RCA) for Asia and the Pacific represent approximately 50% of the world population. It was, therefore, important to the national occupational and environmental radiation protection programmes in the RCA region to have data for their specific populations.

External dosimetry depends little on specific Reference Man characteristics. Normal variations in body size and composition have very little effect on dose determination from exposure to external sources. However, differences between individuals and populations can be very important internal dosimetry considerations.

Determination of the dose per unit intake and annual limits of intake (ALI) depend on anatomical, physiological and metabolic factors. Anatomical data is also very important for developing proper calibration phantoms and procedures for in vivo measurement of radionuclides in occupational radiation protection programmes. Dietary factors play an important role in decisions about food basket management following possible contamination.

The objectives of this CRP were:

(1) Obtain adequate country and region specific data on indigenous populations for comparison with ICRP recommendations.

(2) Identify parameters that are sufficiently different from established recommendations to warrant particular attention in establishing radiation protection programmes.

(3) Develop recommendations, where possible, for use of important, readily measurable anatomical, physiological and metabolic characteristics to scale or predict other, more important parameters.

(4) Identify Reference Man parameters or characteristics for which sufficient additional information is required that a subsequent CRP or related activity would be necessary.

---

[1] Although the terms Reference Asian Man (RAM) and Asian Reference Man (ARM) both appear in the literature, they were considered for the purpose of this CRP to have the same meaning. The former term is used throughout this report for consistency.

The three major aspects of the CRP were compilation of data on (1) anthropomorphic and anatomical parameters, (2) metabolism and (3) physiology. From the beginning, the need for reliable data was considered to be very important.

It must be recognized that funding for the CRP was limited and this constrained the work that could be performed by the participants. In a number of cases, participants compiled existing national data and could conduct only a minimal measurement programme.

Although additional data was welcome, the participants were requested to provide available data on the following specific parameters:

Anthropomorphic Measurements:

Height	**Chest width**
Weight	**Chest depth**
Sitting height	**Head circumference**
Chest circumference	**Neck circumference**

Organ Measurements (Masses and fraction of body mass):

Brain	**Lung**	**Spleen**
Breast (Female)	**Ovaries**	**Testes**
Heart	**Pancreas**	**Thyroid**
Kidney	**Pituitary**	**Thymus**
Liver		

Daily Dietary Intake:

Elemental composition of daily dietary intake

Al, Ba, Ca, Ce, Cl, Cu, I, Fe, La, Mg, Mn, P, K, Na, Sr, S, Th, U and Zn

Daily nutritional intake

Cereals	Algae
Nuts, seeds and pulses	Fish and shellfish
Potatoes and starches	Meats
Sugars and confectioneries	Eggs
Fats and oils	Milk and milk products
Fruits	Seasonings, beverages
Total vegetables	and others

Physiological:

Pulmonary function

Total lung capacity
Vital capacity
Minute volume
8 hour working volume

Water balance

The original protocols for the CRP were developed during the Mito City research co-ordination meeting, and are presented in Appendix I. Where possible, the participants were requested to provide data which represented the age groups: newborn, 1 year, 5 years, 10 years, 15 years and adult (20–50 years). The adult population age range was selected to be consistent with the protocol to be used by the ICRP.

In some cases, the participants were required to provide summary statistical information on large populations (>100 000). Commercial software for the statistical analysis of large data sets is not readily available, particularly for the personal computer. Although some participants had access to commercial products, the IAEA was requested to consider developing and providing PC based software that could be used by all participants so that large data sets could be handled consistently. A description of the code SRT04Z, developed for the CRP by thee IAEA is presented inannex II.

During the conduct of the CRP, major questions arose relating to adequate and appropriate characterization of a Reference Asian Man. These included (1) significant variations between and even within national populations, and (2) secular trends within a given population as a result of changes in food distribution and dietary habits. The problem of population variations on a regional or even national scale is analogous to the difficulty in defining a worldwide Reference Man given differences in major ethnic populations.

The conclusions in this report represent the best effort of the participants to answer these questions.

REFERENCE

[1] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION: Report of the Task Group on Reference Man, ICRP Publication 23, Pergamon Press, Oxford (1975).

2. DATA SUMMARY

2.1. ANTHROPOMORPHIC MEASUREMENTS

J. WANG
Department of Radiation Effects,
Institute of Radiation Medicine,
Chinese Academy of Medical Sciences,
Tianjin, China

Introduction

Based on decisions taken during the Research Coordination Meetings in Mito City 1988 [1] and Bombay 1991 [2], the participants were requested to provide data on physical measurement parameters of body height, body weight, sitting height, head circumference, neck circumference, chest circumference, chest width and chest depth which represented the age groups as newborn, 1 year, 5 years, 10 years, 15 years and adult 20-50 years.

Although physical measurement data was obtained by participants from 9 countries, the data from Indonesia were considered by the national representative to be too few to represent the whole population (804 of all age were measured) [3]. Therefore, Indonesian data were not included in the summary. There is also little data from Bangladesh [4], so the data from Bangladesh were included in the summary but are not used for calculation of the mid-point of specific parameters. Republic of Korea was not represented at the final RCM. However, the data on physical measurement were included in the summary based on the 1991 Project Report submitted to the IAEA [5]. Tables 1-7 summarize the results of measurements for each parameter obtained during the CRP.

Reference Values for Physical Parameters

Significant variations in body height and weight were found within the national populations from different geographical regions, different ethnic and income such as the variations due to locality, religion and income in India [6]; and Chinese variations between urban and rural area populations, and from south to north [7]. Proper sampling and measurement are necessary to assure that the results are representative of the physical characteristics of national populations. Funding for the CRP was limited. As a result, in a number of cases, participants could conduct only a minimal measurement programme, and had to collect and compile existing national data which had been obtained for purposes other than setting reference values of the physique. The data representative for some countries is still in question and some data of parameters such as chest width and depth were absent.

Significant variations in body height and weight were also found among populations of different countries. Considering the body height, the eight countries could roughly be divided into two groups: the first group including China, Japan, the Republic of Korea and Pakistan, and the second group including Bangladesh, India, Philippines and Viet Nam. The average body height of the former is 5 cm higher than that of the latter (168.6 - 163.6). This raises the question of how to adequately characterize the physique of RAM from data collected by the eight countries.

Tables 8-13 present the average values (weighted with equal country value and weighted by population), range, and rounded range mid-point. There are no significant differences among the values of average (by country and by population) and mid-point of range. The participants agreed that the range mid-point would represent the most reasonable compromise if a single value is to be used in practice. However, it was recommended that individual countries use their own national data when specific or detailed evaluations might be necessary.

TABLE I. BODY HEIGHT MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		China		India		Japan		Rep. of Korea		Pakistan		Philippines		Viet Nam	
		X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Male	Newborn	47.3	3.0	50.2	1.2	49.0	2.0	49.7	1.8	-	-	48.8	7.0	-	-	48.7	1.2
	1	71.3	5.3	72.9	4.2	74.4	5.0	75.3	2.3	-	-	-	-	75.7	4.7	74.6	4.2
	5	106.4	8.3	104.6	4.1	102.7	6.0	110.5	4.6	-	-	116.8	6.9	102.9	6.4	98.9	4.3
	10	133.9	7.8	135.5	6.2	128.1	7.0	137.4	5.7	135.8	5.7	143.0	9.4	126.8	6.2	122.2	4.7
	15	162.8	7.7	162.3	7.5	154.2	8.5	167.2	5.9	164.2	6.2	165.1	8.5	155.1	8.2	156.0	6.1
	20-50	163.9	12.8	169.2	5.8	163.4	7.5	167.8	5.7	166.8	5.5	170.6	6.4	163.4	13.8	163.8	5.2
Female	Newborn	47.7	2.5	49.6	1.1	48.0	2.0	49.3	1.8	-	-	48.5	4.2	-	-	48.7	1.2
	1	70.1	3.7	71.3	4.2	72.4	5.5	74.0	2.5	-	-	-	-	75.0	4.9	71.5	4.2
	5	109.7	4.2	103.6	3.6	100.8	9.0	109.6	4.6	-	-	113.5	10.3	102.6	5.9	101.3	4.4
	10	135.4	5.0	133.8	7.0	128.5	7.0	138.4	6.6	136.7	6.2	120.4	10.2	128.9	7.9	124.7	4.9
	15	154.1	5.3	155.4	5.4	148.8	6.0	156.7	5.0	155.4	4.9	154.2	6.6	149.8	5.9	152.1	5.9
	20-50	154.9	5.6	158.2	5.4	151.0	6.5	155.0	5.2	154.9	4.9	157.5	6.7	151.3	5.4	154.0	4.5

TABLE II BODY WEIGHT MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		China		India		Japan		Republic of Korea		Pakistan		Philippines		Viet Nam	
		X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Male	Newborn	2 4	0 7	3 2	0 3	2 9	0 3	3 2	0 4	-	-	3 2	0 6	-	-	3 0	0 3
	1	8 1	1 4	9 1	1 0	8 5	1 5	9 6	1 0	-	-	-	-	9 3	1 4	7 6	2 0
	5	16 4	2 6	16 3	1 4	14 6	2 0	19 0	1 7	-	-	20 3	3 0	15 2	1 7	14 8	2 5
	10	27 2	6 5	27 0	3 9	22 9	3 5	32 5	6 2	30 7	4 5	34 2	7 0	24 3	3 8	23 5	2 6
	15	43 9	6 3	48 6	7 0	38 3	6 5	57 2	9 2	53 2	7 0	51 6	8 8	43 1	7 6	40 9	4 8
	20-50	57 8	9 0	58 3	6 4	51 5	8 5	63 6	8 8	63 8	7 7	63 9	8 1	56 6	8 3	51 8	5 4
Female	Newborn	2 5	0 7	3 1	0 2	2 8	0 3	3 2	0 4	-	-	3 3	0 5	-	-	2 9	0 4
	1	7 0	1 0	8 5	1 0	8 1	1 5	9 1	0 9	-	-	-	-	9 0	1 7	7 8	2 3
	5	16 4	2 5	15 8	1 4	14 2	2 0	18 6	2 6	-	-	15 7	2 5	15 2	1 7	14 5	2 6
	10	26 7	4 3	27 1	4 2	22 9	3 4	32 8	6 3	30 6	5 1	19 1	5 1	25 7	5 0	22 0	2 7
	15	42 5	6 0	46 3	5 5	38 7	6 0	51 6	7 1	49 3	5 8	46 9	7 2	43 3	6 2	40 5	4 6
	20-50	49 9	7 9	51 1	6 4	44 2	8 0	52 3	7 4	54 5	6 5	52 6	8 5	49 2	8 7	46 8	5 3

TABLE III. SITTING HEIGHT MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		China		India		Japan		Republic of Korea		Pakistan		Philippines		Viet Nam	
		X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Male	Newborn	29.1	2.6	33.5	1.4	33.0	3.5	-	-	-	-	-	-	-	-	32.4	1.8
	1	43.6	3.4	46.2	2.7	45.4	2.9	-	-	-	-	-	-	-	-	46.1	1.9
	5	57.6	3.9	59.9	3.7	57.0	3.3	62.3	2.8	-	-	-	-	56.8	3.6	54.5	2.4
	10	70.7	3.9	72.3	2.9	67.5	3.6	74.3	3.1	72.6	2.7	-	-	66.9	3.4	65.6	4.7
	15	85.1	4.1	86.7	4.3	79.8	5.2	89.2	3.5	87.1	4.1	-	-	80.2	4.4	82.2	6.0
	20-50	85.7	3.5	91.8	3.0	85.8	4.7	89.4	2.1	90.1	3.0	-	-	86.0	3.8	86.2	3.8
Female	Newborn	28.3	1.7	32.6	1.4	32.5	2.8	-	-	-	-	-	-	-	-	32.8	1.5
	1	43.2	2.7	45.1	2.1	44.2	2.9	-	-	-	-	-	-	-	-	45.1	1.7
	5	57.9	3.2	59.2	2.7	56.0	3.4	61.9	2.7	-	-	-	-	56.0	2.9	53.7	3.0
	10	67.9	3.3	72.3	3.4	67.1	4.0	75.0	3.6	72.7	3.4	-	-	67.8	3.8	65.5	3.1
	15	80.5	3.2	84.4	3.0	77.9	3.7	85.0	2.8	83.1	2.8	-	-	79.2	3.3	74.0	3.2
	20-50	80.6	3.0	86.2	2.8	80.0	4.1	84.1	1.9	83.9	2.9	-	-	80.3	3.9	81.2	3.6

TABLE IV. HEAD CIRCUMFERENCE MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		China		India		Japan		Republic of Korea		Pakistan		Philippines		Viet Nam	
		X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Male	Newborn	34.1	1.2	34.0	1.2	38.0	3.9	33.6	1.4	-	-	-	-	-	-	31.3	1.1
	1	44.3	1.8	45.2	1.6	44.4	3.6	46.4	1.5	-	-	-	-	-	-	46.6	1.6
	5	49.4	1.8	49.8	1.4	48.5	1.7	51.0	1.7	-	-	49.8	1.5	-	-	49.4	1.5
	10	51.4	1.6	51.3	1.4	50.4	1.7	53.4	1.4	52.6	1.4	51.7	1.7	-	-	52.0	1.5
	15	54.0	1.2	53.9	1.5	52.6	1.8	55.9	1.4	54.5	1.5	53.8	1.8	-	-	53.5	1.5
	20-50	54.8	2.2	56.1	1.6	54.0	2.0	57.6	1.4	56.2	1.5	55.5	1.4	-	-	55.3	1.4
Female	Newborn	33.9	1.5	33.6	1.2	37.0	3.4	33.2	1.4	-	-	-	-	-	-	31.3	1.1
	1	43.8	2.2	44.1	1.6	43.6	1.8	45.3	1.4	-	-	-	-	-	-	45.6	1.6
	5	48.9	2.1	48.8	1.3	47.8	1.7	50.1	1.6	-	-	46.6	2.3	-	-	48.6	1.2
	10	50.9	1.4	50.5	1.8	50.1	1.6	52.7	1.5	52.2	1.4	46.0	4.1	-	-	52.0	1.8
	15	53.0	1.4	52.9	1.4	52.2	1.8	54.8	1.4	54.0	1.4	52.0	2.0	-	-	52.8	1.9
	20-50	53.7	1.4	54.6	1.6	53.1	2.1	55.2	1.5	54.6	1.4	54.8	2.1	-	-	54.3	1.7

TABLE V. NECK CIRCUMFERENCE MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		China		India		Japan		Republic of Korea		Pakistan		Philippines		Viet Nam	
		X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Male	Newborn	20.7	2.0	-	-	-	-	-	-	-	-	-	-	-	-	15.6	0.5
	1	21.8	1.8	-	-	-	-	-	-	-	-	-	-	-	-	22.2	1.0
	5	24.4	1.6	-	-	24.0	2.5	-	-	-	-	-	-	-	-	24.1	1.1
	10	27.2	2.0	-	-	27.8	3.0	-	-	27.7	1.4	-	-	-	-	26.1	1.7
	15	31.3	2.1	-	-	31.0	3.2	-	-	33.0	1.9	-	-	-	-	34.7	1.7
	20-50	34.8	2.3	-	-	35.1	5.8	-	-	36.0	1.8	-	-	-	-	36.1	2.4
Female	Newborn	20.2	2.3	-	-	-	-	-	-	-	-	-	-	-	-	15.4	0.6
	1	20.8	2.1	-	-	-	-	-	-	-	-	-	-	-	-	21.9	0.9
	5	24.3	1.2	-	-	24.1	2.8	-	-	-	-	-	-	-	-	23.7	1.1
	10	27.2	5.0	-	-	27.8	3.1	-	-	27.2	1.6	-	-	-	-	26.2	1.1
	15	28.9	1.5	-	-	31.0	3.6	-	-	-	-	-	-	-	-	31.9	1.3
	20-50	31.0	2.1	-	-	31.2	4.0	-	-	-	-	-	-	-	-	34.0	1.7

TABLE VI. CHEST CIRCUMFERENCE MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		China		India		Japan		Republic of Korea		Pakistan		Philippines		Viet Nam	
		X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Male	Newborn	32.2	2.3	32.4	1.4	35.0	2.5	32.5	1.7	-	-	-	-	-	-	31.8	1.1
	1	43.9	2.5	44.8	2.3	43.3	4.7	46.9	2.2	-	-	-	-	-	-	45.1	1.6
	5	52.8	3.2	53.2	2.2	50.8	5.4	56.2	3.0	-	-	56.4	2.8	-	-	51.7	2.0
	10	62.3	5.9	63.0	3.5	59.1	4.8	66.8	5.5	64.7	3.9	65.5	5.2	-	-	58.8	2.5
	15	70.5	5.5	78.2	5.0	70.9	7.6	82.7	6.2	79.8	5.0	76.9	6.1	-	-	67.2	4.2
	20-50	82.5	6.0	86.7	4.6	80.8	8.7	88.1	4.5	90.5	5.4	85.7	5.9	-	-	82.1	4.1
Female	Newborn	32.3	1.9	32.1	1.4	32.1	3.8	32.4	1.6	-	-	-	-	-	-	31.8	1.3
	1	43.4	2.0	43.7	2.3	42.3	4.0	45.7	1.9	-	-	-	-	-	-	45.3	1.8
	5	51.1	3.9	51.9	2.2	50.1	3.8	54.9	3.0	-	-	49.9	2.6	-	-	51.3	1.8
	10	59.1	4.2	61.2	3.8	58.4	4.7	66.3	5.7	64.0	5.0	61.7	7.5	-	-	51.1	2.7
	15	64.6	5.4	76.2	4.4	71.5	6.5	81.0	5.4	79.8	5.0	70.4	7.9	-	-	64.8	3.1
	20-50	70.8	7.4	80.8	5.7	78.0	6.0	82.9	4.0	85.8	5.9	81.9	9.1	-	-	81.4	3.7

TABLE VII. CHEST DEPTH MEASURED BY THE PARTICIPANTS

Sex	Age (years)	Bangladesh		India		Viet Nam	
		X	SD	X	SD	X	SD
Male	Newborn	6.1	0.8	-	-	7.4	0.4
	1	11.3	1.5	-	-	11.0	0.5
	5	13.4	1.2	13.4	1.5	12.3	0.8
	10	15.7	2.2	13.9	1.7	13.9	1.5
	15	17.9	2.0	15.5	2.6	15.6	1.2
	20-50	19.8	2.4	18.7	2.1	21.4	1.2
Female	Newborn	6.7	0.8	-	-	7.4	0.3
	1	10.6	1.7	-	-	11.0	0.5
	5	12.5	1.6	13.0	2.1	11.9	0.8
	10	14.2	1.5	13.4	2.4	13.2	1.4
	15	15.9	1.8	16.0	3.8	14.6	1.4
	20-50	18.1	3.1	18.2	3.7	21.7	1.6

TABLE VIII. AVERAGE, RANGE AND RANGE MID-POINT VALUES AT AGE 20-50 FOR EACH PARAMETER

Male	X ± SD		Range		Range Mid-point Value*
	Equal country weighting	Population weighting	Min.	Max.	
Height (cm)	166.1 ± 2.9	166.7 ± 2.8	163.4	170.6	167.
Weight (kg)	58.4 ± 5.1	56.5 ± 4.1	51.5	63.9	58.
Sitting height (cm)	88.0 ± 2.7	88.9 ± 4.7	85.5	91.8	89.
Head circumference (cm)	55.7 ± 1.2	55.3 ± 2.1	54.0	57.6	56.
Neck circumference (cm)	35.0 ± 0.7	35.2 ± 5.2	35.1	36.1	36.
Chest circumference (cm)	85.2 ± 3.6	84.5 ± 7.1	80.8	90.5	86.
Chest depth (cm)	20.0 ± 1.4	20.0 ± 2.2	18.7	21.4	20.
Female					
Height (cm)	154.6 ± 2.6	155.1 ± 3.3	151.0	158.2	155.0
Weight (kg)	50.1 ± 3.3	48.8 ± 3.4	44.2	54.5	50.0
Sitting height (cm)	82.3 ± 2.9	83.4 ± 4.4	80.0	86.2	83.0
Head circumference (cm)	54.3 ± 0.7	54.1 ± 2.0	53.1	55.2	54.0
Neck Circumference (cm)	32.1 ± 1.7	31.4 ± 3.8	31.2	34.0	33.0
Chest circumference (cm)	80.2 ± 4.8	79.7 ± 6.6	78.0	85.8	82.0
Chest depth	19.3 ± 2.1	19.8 ± 3.4	18.2	21.7	20.0

* Rounded to nearest 2 significant figures

TABLE IX. AVERAGE, RANGE AND RANGE MID-POINT VALUES AT AGE 15 FOR EACH PARAMETER

Male	X ± SD		Range		Range Mid-point Value*
	Equal country weighting	Population weighting	Min.	Max.	
Height (cm)	160.9± 5.0	159.7 ± 4.4	154.2	167.2	161.
Weight (kg)	47.1 ± 6.6	45.3 ± 5.7	38.3	57.2	48.
Sitting height (cm)	84.3 ± 3.6	84.0 ± 5.8	79.8	89.2	85.
Head circumference (cm)	54.0 ± 1.0	53.6 ± 1.8	52.6	55.9	54.
Chest circumference (cm)	75.2 ± 5.7	75.2 ± 7.4	67.2	82.7	75.
Female					
Height (cm)	153.3 ± 2.8	152.9 ± 3.1	148.8	156.7	153.
Weight (kg)	44.9 ± 4.4	43.7 ± 4.0	38.7	51.6	45.
Sitting height (cm)	80.6 ± 3.9	81.5 ± 10.5	74.0	85.0	80.
Head circumference (cm)	53.1 ± 1.0	52.7 ± 1.7	52.0	54.8	53.
Chest circumference (cm)	72.6 ± 6.7	73.8 ± 6.7	64.8	81.0	73.

* Rounded to nearest 2 significant figures

TABLE X. AVERAGE, RANGE AND RANGE MID-POINT VALUES AT AGE 10 FOR EACH PARAMETER

Male	X ± SD		Range		Range Mid-point Value*
	equal country weighting	population weighting	Min.	Max.	
Height (cm)	132.8 ± 6.7	132.9 ± 4.6	122.2	143.0	133.
Weight (kg)	27.8 ± 4.3	26.2 ± 3.1	22.9	34.2	28.
Sitting height (cm)	70.0 ± 3.3	70.3 ± 4.2	65.6	74.3	70.
Head circumference (cm)	51.8 ± 1.0	51.2 ± 1.7	50.4	53.4	52.
Chest circumference (cm)	62.9 ± 3.1	61.9 ± 4.9	57.8	66.8	62.
Female					
Height (cm)	130.9 ± 6.3	131.4 ± 4.1	120.4	138.4	130.
Weight (kg)	25.9 ± 4.5	25.5 ± 3.0	19.1	32.8	26.
Sitting height (cm)	69.8 ± 3.5	70.1 ± 4.6	65.5	75.0	70.
Head circumference (cm)	50.6 ± 2.3	50.4 ± 2.2	46.0	52.7	49.
Chest circumference (cm)	60.3 ± 4.9	60.2 ± 5.1	58.4	66.3	62.

* Rounded to nearest 2 significant figures

TABLE XI. AVERAGE, RANGE AND RANGE MID-POINT VALUES AT AGE 5 FOR EACH PARAMETER

Male	X ± SD		Range		Range Mid-point Value*
	by country	by population	Min.	Max.	
Height (cm)	106.1 ± 5.9	104.7 ± 3.4	98.9	116.8	108.
Weight (kg)	16.7 ± 2.2	16.0 ± 1.5	14.6	20.3	17.
Sitting height (cm)	58.0 ± 2.7	58.6 ± 3.9	54.5	62.3	58.
Head circumference (cm)	49.7 ± 0.8	49.4 ± 1.7	48.5	51.0	50.
Chest circumference (cm)	53.5 ± 2.3	52.6 ± 4.1	50.8	56.4	54.
Female					
Height (cm)	105.9 ± 5.0	104.0 ± 3.4	100.8	113.5	107.
Weight (kg)	15.8 ± 1.5	15.4 ± 1.1	14.2	18.6	16.
Sitting height (cm)	57.5 ± 2.9	57.9 ± 3.6	53.7	61.9	58.
Head circumference (cm)	48.5 ± 1.2	48.4 ± 1.7	46.6	50.1	48.
Chest circumference (cm)	51.5 ± 1.8	51.2 ± 3.2	49.9	54.9	52.

* Rounded to nearest 2 significant figures

TABLE XII. AVERAGE, RANGE AND MID-POINT VALUES AT AGE 1 FOR EACH PARAMETER

Male	X ± SD		Range		Range Mid-point Value*
	Equal country weighting	Population weighting	Min.	Max.	
Height (cm)	74.0 ± 1.7	73.7 ± 1.0	72.9	75.7	74.
Weight (kg)	8.7 ± 0.8	8.8 ± 0.4	7.6	9.6	8.7
Sitting height (cm)	46.1 ± 2.0	45.9 ± 2.9	45.4	46.2	46.
Head circumference (cm)	45.4 ± 1.1	45.0 ± 2.6	44.4	46.6	46.
Chest circumference (cm)	44.8 ± 1.4	44.3 ± 3.5	43.3	46.9	45.
Female					
Height (cm)	72.4 ± 1.8	71.9 ± 1.0	71.3	75.0	73.
Weight (kg)	8.3 ± 0.8	8.3 ± 0.4	7.8	9.1	8.4
Sitting height (cm)	45.2 ± 2.0	44.9 ± 2.7	44.2	45.1	45.
Head circumference (cm)	44.5 ± 0.9	44.0 ± 1.8	43.6	45.6	45.
Chest circumference (cm)	44.1 ± 1.4	43.3 ± 3.2	42.3	45.7	44.

* Rounded to nearest 2 significant figures

TABLE XIII. AVERAGE, RANGE AND MID-POINT VALUES OF NEWBORN FOR EACH PARAMETER

Male	X ± SD		Range		Range Mid-point Value*
	by country	by population	Min.	Max.	
Height (cm)	49.0 ± 1.0	49.5 ± 0.8	48.8	50.2	50.
Weight (kg)	3.0 ± 0.3	3.1 ± 0.2	2.9	3.2	3.1
Head circumference (cm)	34.2 ± 2.4	35.4 ± 3.3	31.3	38.0	35.
Chest circumference (cm)	32.8 ± 1.3	33.3 ± 2.3	31.8	35.0	33.
Female					
Height (cm)	48.6 ± 0.7	48.9 ± 0.8	48.0	49.6	49.
Weight (kg)	3.0 ± 0.3	3.0 ± 0.2	2.8	3.3	3.1
Head circumference (cm)	33.8 ± 2.7	34.8 ± 2.9	31.3	37.0	34.
Chest circumference (cm)	32.1 ± 0.2	32.1 ± 2.6	31.8	32.4	32.

* Rounded to nearest 2 significant figures

The distribution of height and weight values are illustrated in Figures 1 and 2, and 3 and 4, respectively. Individual national values for median and standard deviation were used as a basis for establishing normal (Gaussian) distributions as a manner of illustrating the relationship of the regional values of adult height and weight. Equivalent values for the revised ICRP Reference Man are presented for comparison.

An additional problem in establishment of reference values for physique are the secular trends seen in some countries as the population characteristic change with changing dietary conditions and life styles. As an example, Figure 5 reflects an increase in height for 17 year old Japanese males of 1.5 cm over a period of 15 years from 1977 to 1991 [8]. Secular trends vary from country to country. For the developed countries such as West European and North American no acceleration of growth has been seen in recent years, so the secular trends can be neglected. However, for the developing countries the acceleration of growth in body height, weight and others must be considered.

As a result of changes in food distribution and dietary habits with the socioeconomic conditions, improved the acceleration of growth were become significant. Table 14 shows the comparison of body height growth among students in Beijing of China with those in Japan [9]. From 1955-1985 the incremental rate of growth has dropped step by step for Japanese students, but for Chinese students it rose gradually. The same situation can be found from the data of the Republic of Korea, Viet Nam [10], the Philippines [11] and India [12]. The lower mean height and weight of developing countries population were caused by a large proportion of the population suffering from various degrees of undernutrition and malnutrition. As a result, they are not able to attain fully their genetic potential with regard to somatic development. For example, in India the growth and development of children from affluent families is better than the average level of China and Japan (Table 15). Affluent Indians, in fact, have body weights similar to those of ICRP Reference Man [13]. It is, therefore, necessary to address secular trends when setting reference values of physique.

TABLE XIV. COMPARISON OF INCREMENTAL RATE OF GROWTH IN HEIGHT AMONG BEIJING'S STUDENTS WITH THOSE AMONG JAPANESE STUDENTS

Sex	Age (years)	1955-1965				1965-1975				1975-1985			
		Beijing		Japan		Beijing		Japan		Beijing		Japan	
		Incremental value	Rate %	Incremental value	Rate %	Incremental value	Rate %	Incremental value	Rate %	Incremental value	Rate %	Incremental value	Rate %
Male	7	1.69	1.42	2.7	2.34	2.71	2.25	2.6	2.20	1.32	1.10	1.54	1.28
	8	1.83	1.50	3.7	3.08	3.81	3.08	2.0	1.61	1.44	1.13	0.84	0.66
	9	2.19	1.72	3.7	2.96	2.56	1.98	2.8	2.17	2.25	1.70	0.94	0.72
	10	1.87	1.41	4.0	3.09	1.18	0.88	2.8	2.10	3.53	2.60	1.09	0.80
	11	2.33	1.72	4.7	3.51	1.87	1.35	3.4	2.45	4.88	3.20	1.44	1.02
	12	0.97	0.68	5.5	3.95	2.68	1.87	3.9	2.70	3.99	2.73	1.82	1.23
	13	1.48	1.00	6.4	4.40	2.56	1.71	4.4	2.90	7.56	4.97	2.00	1.28
	14	1.23	0.79	6.6	4.35	1.39	0.89	3.9	2.46	7.39	4.68	1.75	1.08
	15	1.17	0.73	5.1	3.32	1.51	0.93	2.5	1.53	5.99	3.66	1.26	0.76
	16	0.73	0.44	4.1	2.54	1.94	1.17	2.2	1.33	3.37	2.01	1.05	0.63
	17	2.13	1.28	3.4	2.08	-0.18	-0.11	2.0	1.20	3.95	2.34	1.38	0.82
	Mean	1.60	1.15	4.5	3.04	2.00	1.45	2.5	2.06	4.15	2.74	1.37	0.93
Female	7	1.22	1.04	3.2	2.79	2.82	2.37	2.3	1.95	1.25	1.03	1.31	1.09
	8	1.26	1.04	3.7	3.10	4.46	3.65	2.4	1.95	1.60	1.26	0.52	0.41
	9	1.38	1.09	4.0	3.21	3.45	2.70	3.1	2.41	2.67	2.04	1.15	0.88
	10	1.15	0.87	4.7	3.63	4.42	3.32	3.4	2.53	2.70	1.97	1.54	1.12
	11	2.81	2.06	5.5	4.08	3.80	2.73	3.8	2.71	3.90	2.73	1.51	1.05
	12	1.92	1.34	5.3	3.76	3.86	2.66	3.3	2.26	2.86	1.92	1.33	0.89
	13	1.96	1.32	4.6	3.16	1.46	0.97	2.9	1.93	4.62	3.63	0.99	0.65
	14	2.33	1.53	3.6	2.42	-0.44	-0.28	2.5	1.64	3.94	2.55	1.19	0.77
	15	3.05	1.98	2.3	1.52	-0.08	-0.05	1.7	1.10	2.51	1.60	1.32	0.85
	16	1.59	1.02	3.0	1.97	1.55	0.99	0.6	0.93	1.82	1.15	1.06	0.68
	17	1.35	0.86	1.6	1.04	-0.32	-0.20	1.5	0.97	2.69	1.71	1.11	0.71
	Mean	1.82	1.29	3.77	2.79	2.27	1.71	2.52	1.80	2.78	1.91	1.18	0.82

TABLE XV. MEAN HEIGHT AND WEIGHT OF AFFLUENT INDIAN CHILDREN

Age (years)	Male		Female	
	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)
1	80.1	10.5	78.1	10.0
5	113.5	19.3	112.2	18.7
10	138.5	32.3	138.9	33.6
14	161.7	48.3	155.0	46.7
16	168.4	55.5	156.0	49.8
18	172.1	58.4	158.0	50.7
22	171.6	60.1	-	-

If the secular trends for height and weight were chosen as 0.1-0.15 cm per year and 0.1-0.15 kg per year respectively, and the year of measurement shown in this report is assumed to be 1985, by the year 2005 the reference values of height and weight would be 169-170 cm and 60-61 kg for male adults and 157-158 cm and 52-53 kg for female adults. These are very close to those presented in G. Tanaka's model which is 170 cm and 60 kg and 160 cm and 52 kg respectively for male and female adults [13,14]. This model probably represents the most complete and detailed characterization of Reference Asian Man at the end of the decade. In any event, it is clear that there are many limitations and uncertainties for the proposed reference value of physical parameters. Adequate and appropriate characterization for the RAM needs systematic studies.

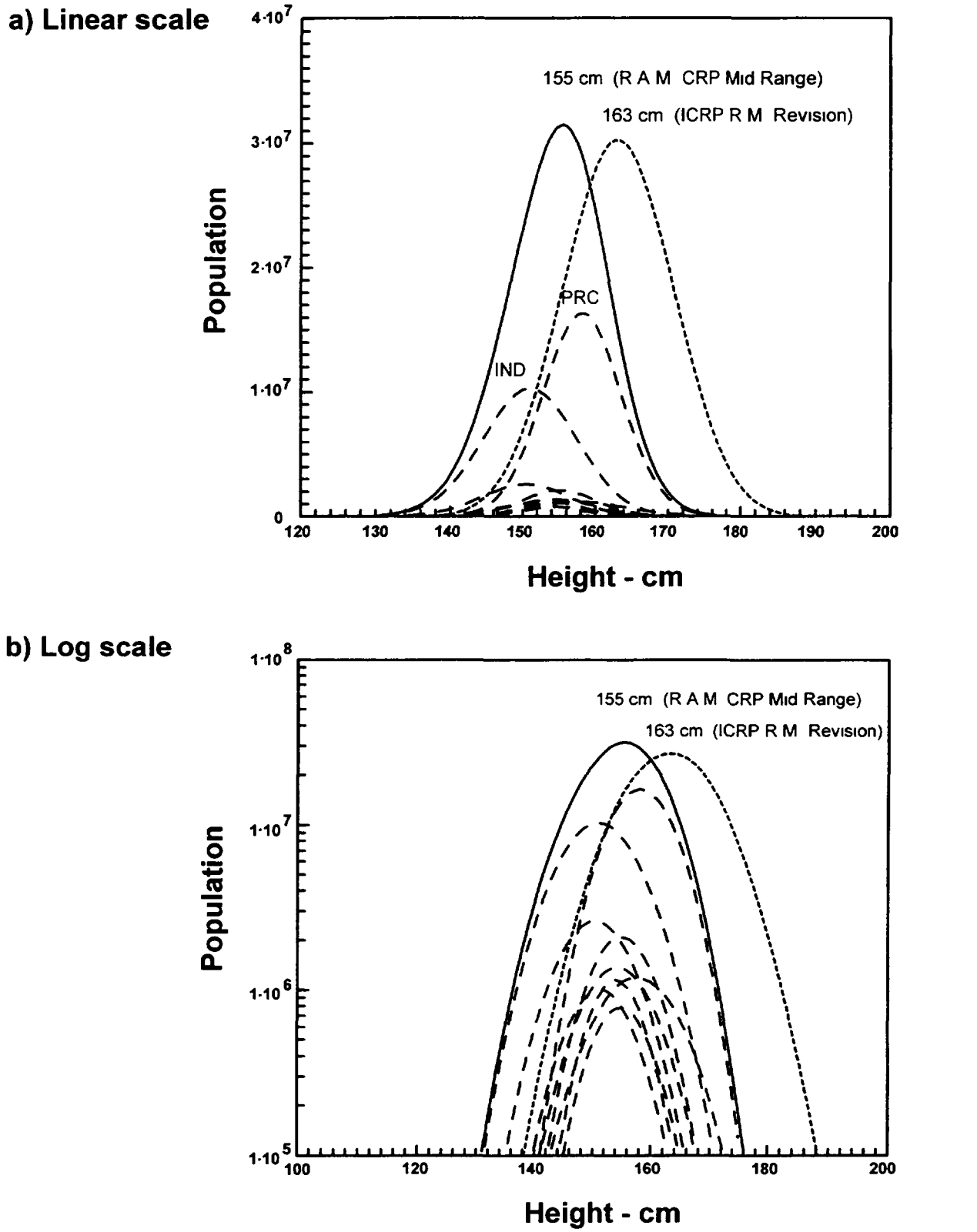


FIG. 1. Comparison of adult female heights (distributions assumed to be Gaussian)

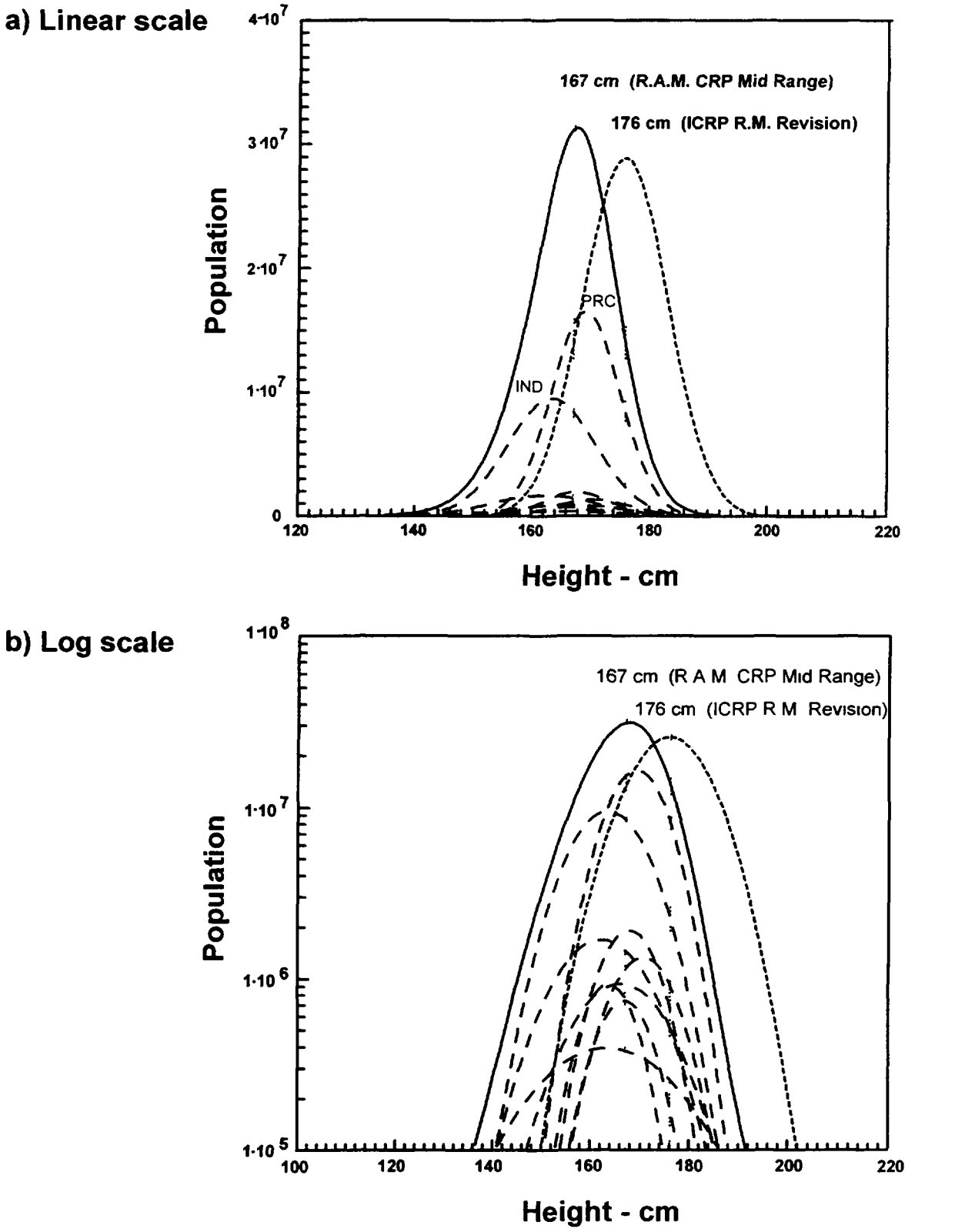


FIG 2 Comparison of adult male heights (distributions assumed to be Gaussian)

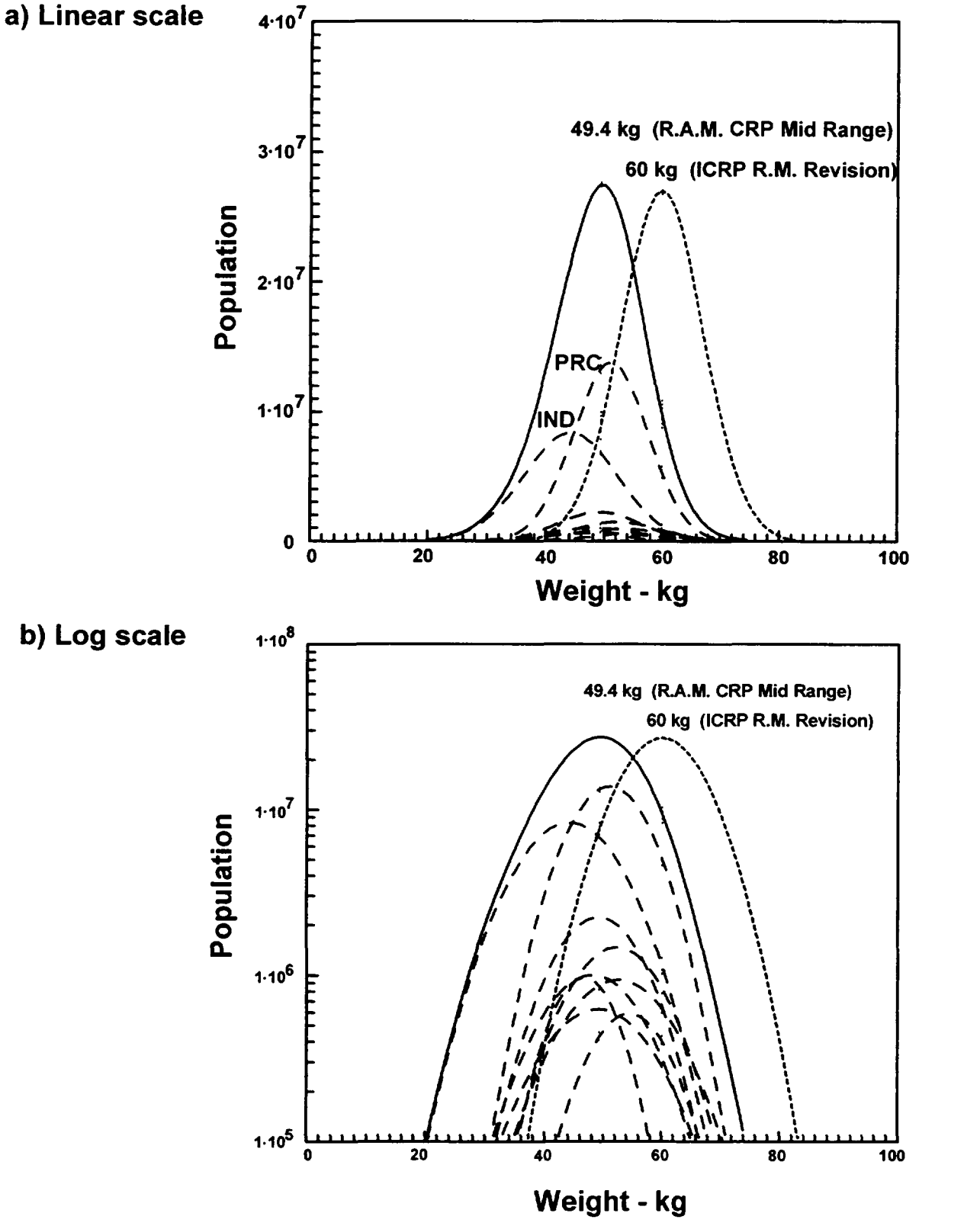


FIG. 3. Comparison of adult female weights (distributions assumed to be Gaussian)

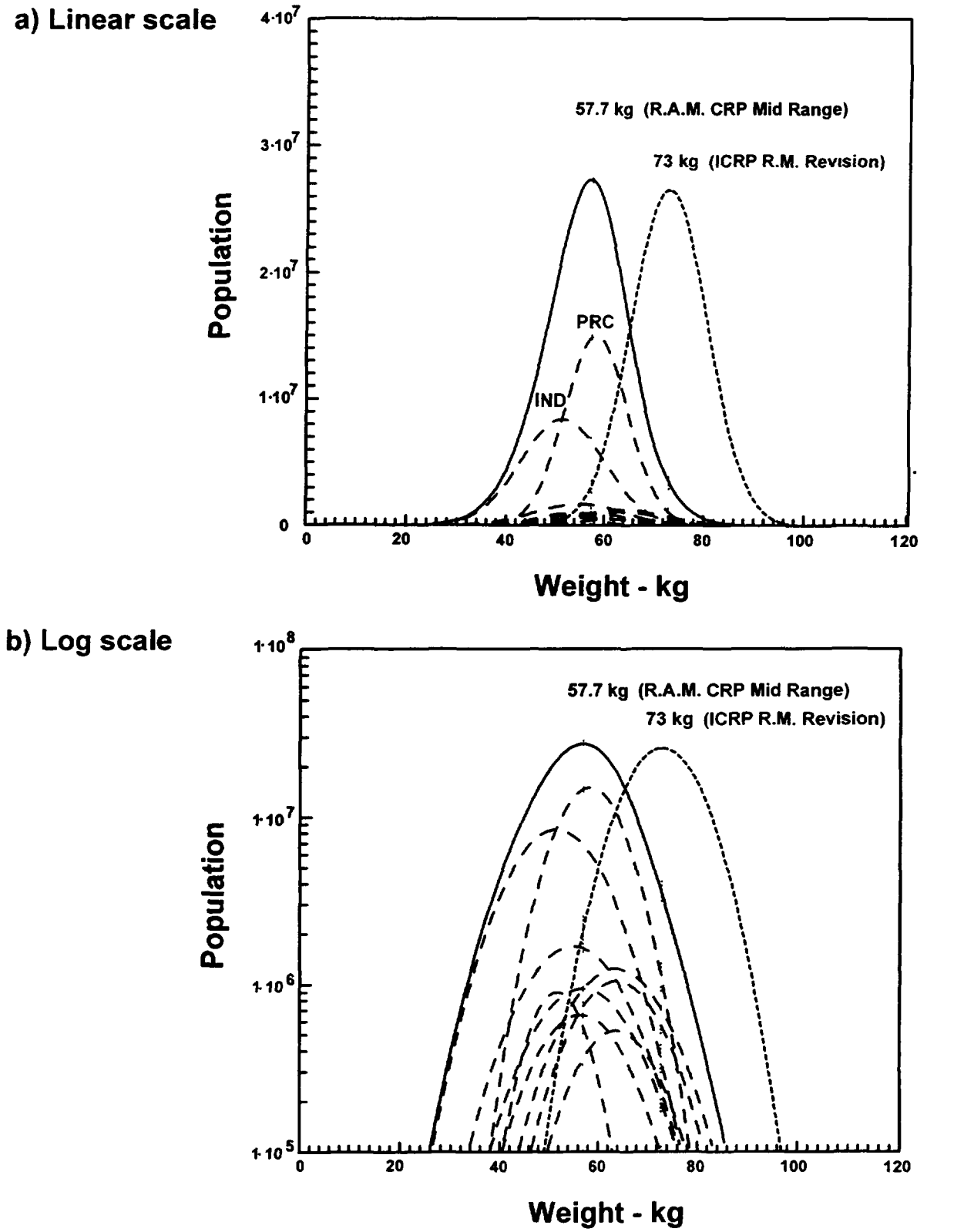


FIG 4 Comparison of adult male weights (distributions assumed to be Gaussian)

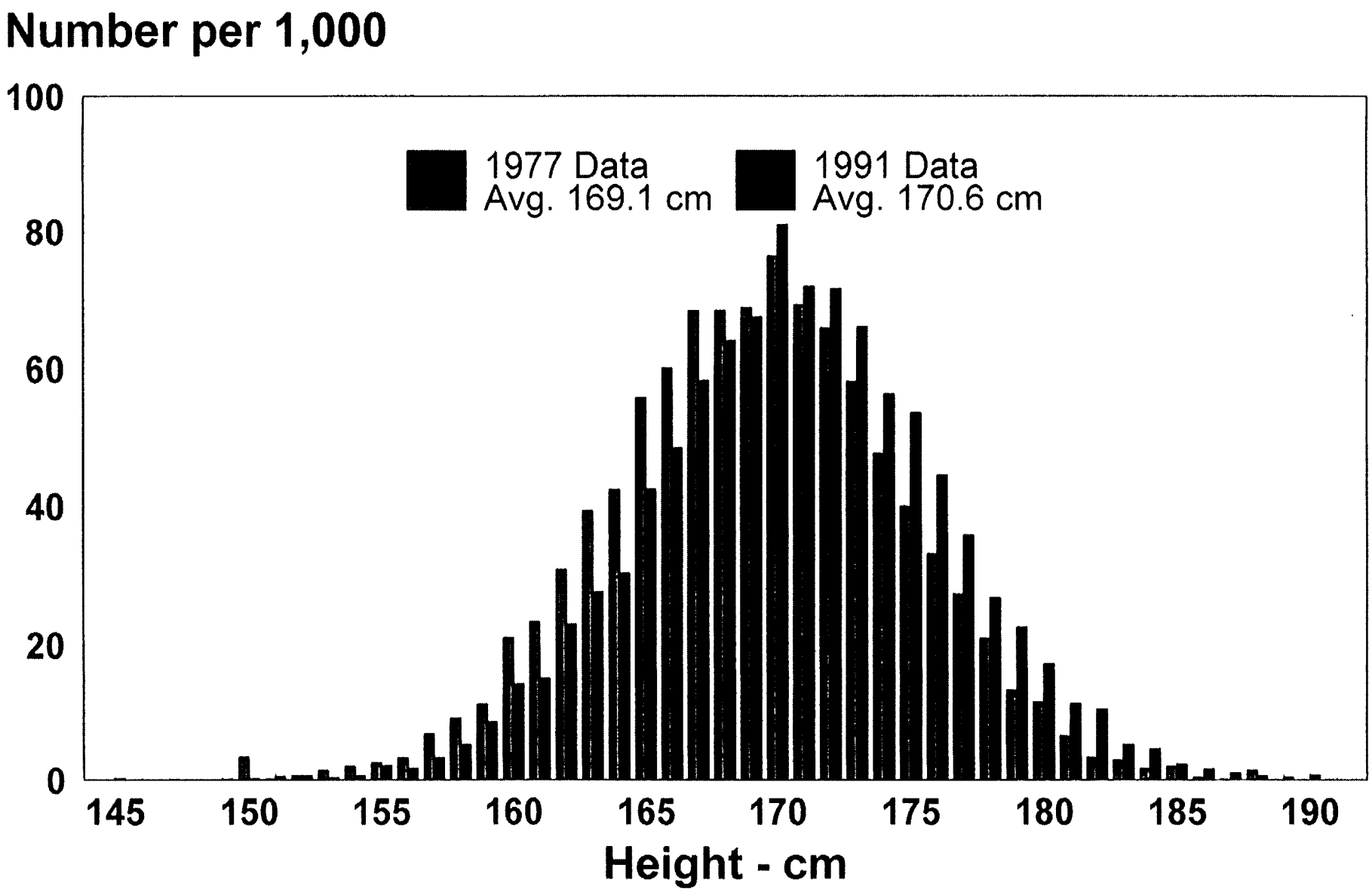


FIG. 5. Example of the effect of secular change in the physical characteristics of a population: Height distribution of 17 year old Japanese males, 1977 to 1991.

REFERENCES

[1] Project Formulation Meeting, IAEA/RCA CRP on Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, Mito City, Japan, 1988.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, Working Material for Research Coordination Meeting, Bombay, India, 8-12 April, 1991. IAEA-J3-RC-451.

[3] Indonesia Country Report on the IAEA/RCA CRP RCM on Reference Asian Man, Tianjin, China, 1993.

[4] MIAH, F.M., et al., Country Report on the IAEA/RCA CRP RCM on Reference Asian Man, Tianjin, China, 1993.

[5] NIRS, "An Abridged Data of IAEA-RCA-CRP on Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man", Tianjin, China, 1993.

[6] DANG, H.S., et al, Some Selected Human Parameters for Setting up Reference Indian Man, presented at IAEA/RCA CRP experts group meeting on Reference Asian Man, Chiba, Japan, 1992.

[7] JIXIAN WANG et al, Reference values of body height and weight in China, Chin. J. Radial. Med. Prot. 13(1):3, 1993.

[8] GI-ICHIRO TANAKA, Reference Japanese, Volume 3 - Correlation Between Body Height and Weight for the Age Group of 0 to 17 Years Old (Data by Ministry of Education), *In Draft* (1994).

[9] Research Section of the Constitution and Health of Chinese students, P788, People's Education, Press, 1987.

[10] NGUYEN MAN LIEN et al., Country Report on IAEA/RCA CRP REM on Reference Asian Man, Tianjin, China, 1993.

[11] NATERA, E.S., Country Report on IAEA/RCA CRP RCM on Reference Asian Man, Tianjin, China, 1993.

[12] SUNTA, C.M., et al., Status Report on IAEA/RCA CRP RCM on Reference Asian Man, Bombay, India, 1991.

[13] NARASING A RAO, B.S., Some anthropometric and metabolic aspects of Indian Reference Man, Nutritional Considerations, IAEA/RCA CRP RCM on Reference Asian Man, Bombay, India, 1991.

[13] GI-ICHIRO TANAKA, Anatomical and Physical Characteristics for Asian Reference Man, A Proposal NIRS-M-95, 1993.

[14] TANAKA, G., KAWAMURA, H., Reference Japanese Man, Reported on IAEA/RCA RCM on Reference Asian Man, Tianjin, China, 1993.

2.2. ORGAN MASS MEASUREMENTS

H. KAWAMURA
Division of Radioecology,
National Institute of Radiological Sciences,
Hitachinaka, Ibaraki, Japan

Introduction

The term, anatomical measurements, in the context of this Co-ordinated Research Programme refers to measurements of masses of internal organs [1], although the human body is composed of internal organs and tissues such as skeleton, muscle, skin and adipose [2]. The mass of an organ containing a radionuclide (source organ), and the mass of a target organ which absorbs energy of the radiation, are essential parameters in the ICRP dosimetric model derived from the MIRD method [3]. Twelve specific organs of interest were proposed at the Coordinated research Programme Project Formulation Meeting (PFM) in 1988 [1]. A slightly different set of thirteen organs with potential significance for radiation protection were seleted for study at the Research Co-ordination Meeting held at the Bhabha Atomic Research Centre in 1991 [4, Appendix 2]. The dimensions of the organs could also be useful information, but were considered unimportant for internal dose assessment. Due to the strong concern about the unified method for collecting organ mass data at the PFM, a guide-line was established [1] stressing the need for organ data from subjects that were healthy and normal, at least until shortly before death, or from sudden death cases, following the Japanese experience.

In this report, masses of nine to thirteen organs are presented from seven participating countries. Three participants have also reported the organ masses as fractions of the total body mass.

Materials and Methods

At the beginning of the CRP, the following criteria for obtaining normal values of mass of internal organs were proposed and approved [1, Appendix D]. The criteria apply both to compilation of published literature survey data and specific measurements by the participants:

(1) Subjects are to be studied who died suddenly.
(2) Autopsy should be carried out by qualified medical doctors within 24 hours after death (in case of the temperate zone) in such a way that in situ mass of organs might be obtained.
(3) Data should be obtained from those who are found at autopsy to have been healthy and normal shortly before death.
(4) Data should be obtained from those who do not show any of the following pathological changes in any organ(s): inflammation, anemia, atrophy, regressive change, fatty degeneration, neoplasm, or tumor, all of which tend to cause a change in the normal weight of organs.

Nutritional condition as well as the height and weight of the body may also be observed.

The organs proposed for study were: the adrenal gland, brain, heart, kidney, liver, lung, pancreas, pituitary gland, spleen, testis, thymus, and thyroid gland. Later, on the advice of

the ICRP Reference Man Task Group, female breast and ovaries were added and adrenals were omitted from the list [4].

A summary of the populations studied, and materials and methods used for collecting data on masses of organs is shown in Table 1. In case of China [5] and India [6], the data were obtained for sudden death victims from published reports and from medical institutions in different locations in each country. In Indonesia [7], the data was obtained by medical doctors in forensic science with standard autopsy techniques, together with tissue sampling from some male subjects for chemical analysis. In Japan [8] the normal data was obtained from such subjects who died of sudden deaths such as traffic accidents, etc. through collaboration with Tokyo Medical Examiner's Office which deals with autopsy to find cause of death for administrative purposes. In the Republic of Korea [9], the data were obtained in 1982, with little additional data. Since the original paper written by the participant was not available, the methods used were not known form compilation of this summary. In the Philippines [10], the data was obtained for medico-legal cases in co-operation with relevant institutions in Metro Manila as well as at the two other hospitals outside the capital. In Viet Nam [11], data were requested from a number of hospitals with instructions on the proper procedures to be used. The received data were reviewed and selected.

There are a few points to be noted when comparing the reported data as follows:

(1) Individual conditions for autopsy and measurement in each country were not necessarily known for all countries.
(2) Nutritional backgrounds are not exactly the same as are described in elsewhere in this TECDOC.
(3) Little data was obtained for ages 15-16, and under in some countries, comparison of all the organ masses of younger ages may not be very meaningful ($n < 10$ to $n < 80$).
(4) Slightly different age brackets from those requested in the reporting format were employed by some participants for practical reasons. This would make comparison difficult especially for the "newborn" (i.e. less than 1 m to less than 1 y) and 1 y (i.e. 1 y to 1-2 y) as shown in Table 2.

Results and Discussion

Mass of organs-growth pattern and adult mean

The average masses and standard deviations of individual organs for each age group, reported by the participants [5-11] are summarized in Tables 3-14. For practical purposes, the masses for those organs which have two lobes, i.e. the lung, kidney, thyroid gland, testis and adrenal gland, have been summed for presentation here. Results for brain, liver, pancreas, testis and thyroid are shown graphically in Figs 1-9. These also provide a rough indication the growth changes. Presentation of growth curves for normal Japanese from that report is reproduced in Fig. 10 which may present typical changes in organ masses to over age 70 [12]. A detailed study of the Japanese population has been compiled and published [13], and is here referred to as the "Tanaka Model".

The composite averages and standard deviations of the reported national means were calculated as in Tables 15-16. It should be noted that the overall results are inhomogeneous. The values from the ICRP Reference Man [2] data and Tanaka Model for Reference Asian Man [13] are included in the tables for comparison and are graphically shown in Figs. 11-12.

TABLE I. MATERIALS AND METHODS USED FOR COLLECTING DATA ON MASSES OF ORGANS

Country	Location	Period of study	Original data source	Cause of death	No. of subjects	Method of measurement/ evaluation
China (CPR)		1950-90	15 medical colleges 33 medical colleges CIRP Capital I. Children	Sudden deaths	19,976 4070 (18-55y) 1000 (children)	The criteria followed Data selected
India (IND)	18 cities 4 areas	1963	Venkataraman et al. 24 med. institutions 4 or more medical institutions	Accidental deaths	10,000 (M), 4,500 (F) 10-50 for each younger age group	Data critically evaluated
Indonesia (IDN)	Jakarta	1989-90	Widiatma et al. Forensic Med., University of Indonesia	Sudden deaths Normal until shortly before death	120 (M), 35 (F) (10-72y)	Domestic standard procedure, measure & weigh after cleaning within 24 h after death
Japan (JPN)	Tokyo	1970-80	Tanaka et al. Medical examiner's Office NIRS	Sudden deaths Normal, healthy until shortly before death Administrt. cases	3,900 (M), 1470 (F) <70 for each younger age group	Within 12-24 hour after death, cadaver weighed. Visual examination for pathological changes
Republic of Korea (ROK)		1982	Kim et al., Republic of Korean Adv. En. Res. Inst.		1,344 (M), 577 (F)	Not specified
Philippines (PHI)	North South Manila	1984 and after	Baguio General Hospital V. Sotto G. Hospital Santo Tomas University Hospital, P.C.C.L. & P.B.I.	Medico-legal cases	1,191 (M), 236 (F) <10 for each younger age group	Visually examined for pathological changes
Viet Nam (VIE)			Various hospitals		220(M), 220(F)	(Instructions forwarded, Received data selected)

TABLE II COMPARISON BETWEEN THE REQUIRED AND ACTUAL AGE RANGES

Age range, as required	Age range used in individual country reports						
	China	India	Indonesia	Japan	Republic of Korea	Philippines	Viet Nam
Newborn	<1 m	N B	-	0-1 m	-	<1 y	N B
1 y	1 y	1 y	-	1 y	-	1-2 y	1 y
5 y	5 y	5 y	-	5 y	-	5-6 y	5 y
10 y	10 y	10 y	10-12 y	10 y	-	9-10 y	10 y
15 y	15 y	15 y	13-15 y	15 y	-	15-16 y	15 y
20-50 y	20 y	>18 y	20-39 y	20-50 y	Adult	20-50 y	Total adult
	30 y						
	40 y						

Brain

The brain mass increases rapidly after birth and, as shown in Table 3 and Fig. 1-2, it approaches the adult level at ages 5 to 10. At age 5, a somewhat slower growth rate is suggested by the data from India (Table 3, Fig 1-2). For all ages, the male brain mass was observed slightly larger than that for females. Relative standard deviation of the adult brain weight was relatively small as 6.0-10.3%. In the adult male, the range found was 1236 g (India) -1442 g (Japan) with an arithmetic mean 1361±77 g (RSD 5.7%) as shown in Table 15. The reason for the intra-regional difference was not clear taking individual standard deviations into account. The brain mass from the Tanaka Model, 1470 g for adult male is within ± 8% level, which compares with 1400 g of the ICRP Reference Man.

For the adult female, the range found was 1140 g (India) to 1321 g (Japan) with a mean of 1262±74 g. This is only 58 g smaller than the value from the Tanaka Model and 62 g larger than the ICRP Reference Woman value as shown in Table 16.

Breast

Only the Viet Namese report provided data for breast [11]. From that report, the breast mass grows slowly. At 15 years, it becomes about 4.6 times that at 10. Relative standard deviation of the breast weight in the adult was 18%. In this report [Ref. 11, Table 5], the weight is referred to as that of the breast (right), but it is assumed to be the total weight of the right and left. The figure is 50 g less than that assumed by the Tanaka Model for Reference Asian adult female, and 110 g smaller than that of the ICRP Reference Woman as shown in Table 16.

Heart

The heart weight increases gradually with age as shown in Table 4. There is no apparent difference in the data reported here in the growth pattern found among the locations. Over 10 years, the male heart was larger than that of the female, though within one standard deviation. There are some differences in the average heart weights for the adult male among the countries form a minimum for India (243 g) to a maximum for Japan (379 g). The mean is 303±53 g. The relative standard deviations in the adult ranged from 10.0% (Viet Namese) to 23.8% (Japanese). The mean is 20% smaller than that for the Tanaka Model (380 g). In comparison with the ICRP Reference Man (330 g), it is only 8% smaller.

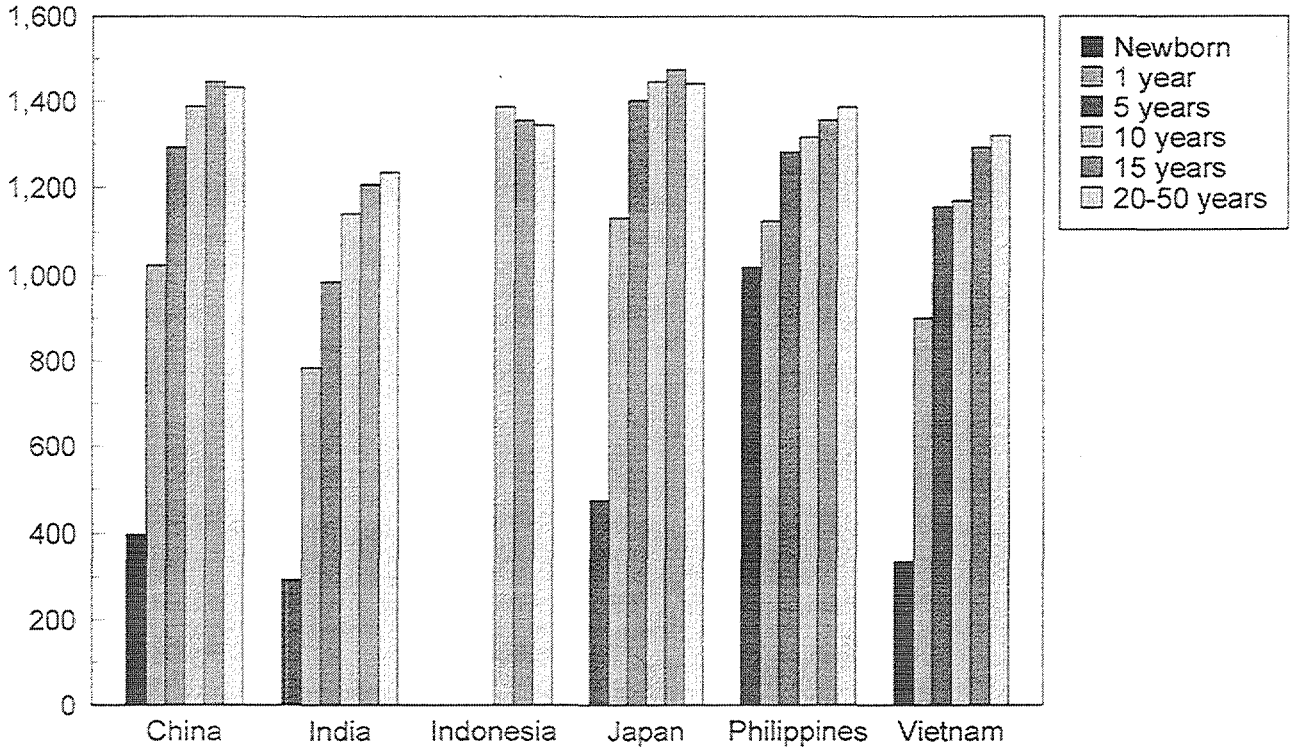


FIG. 1. Male brain mass — grams.

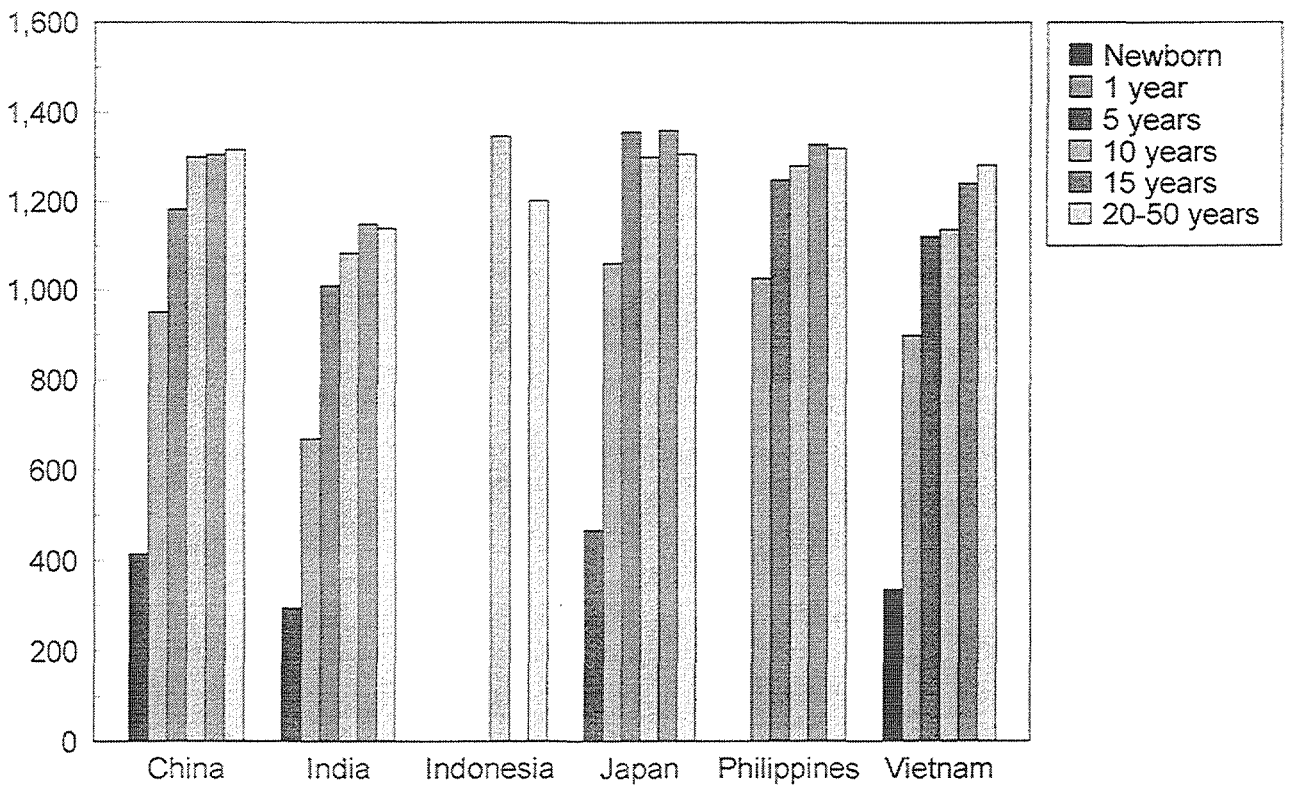


FIG. 2. Female brain mass — grams.

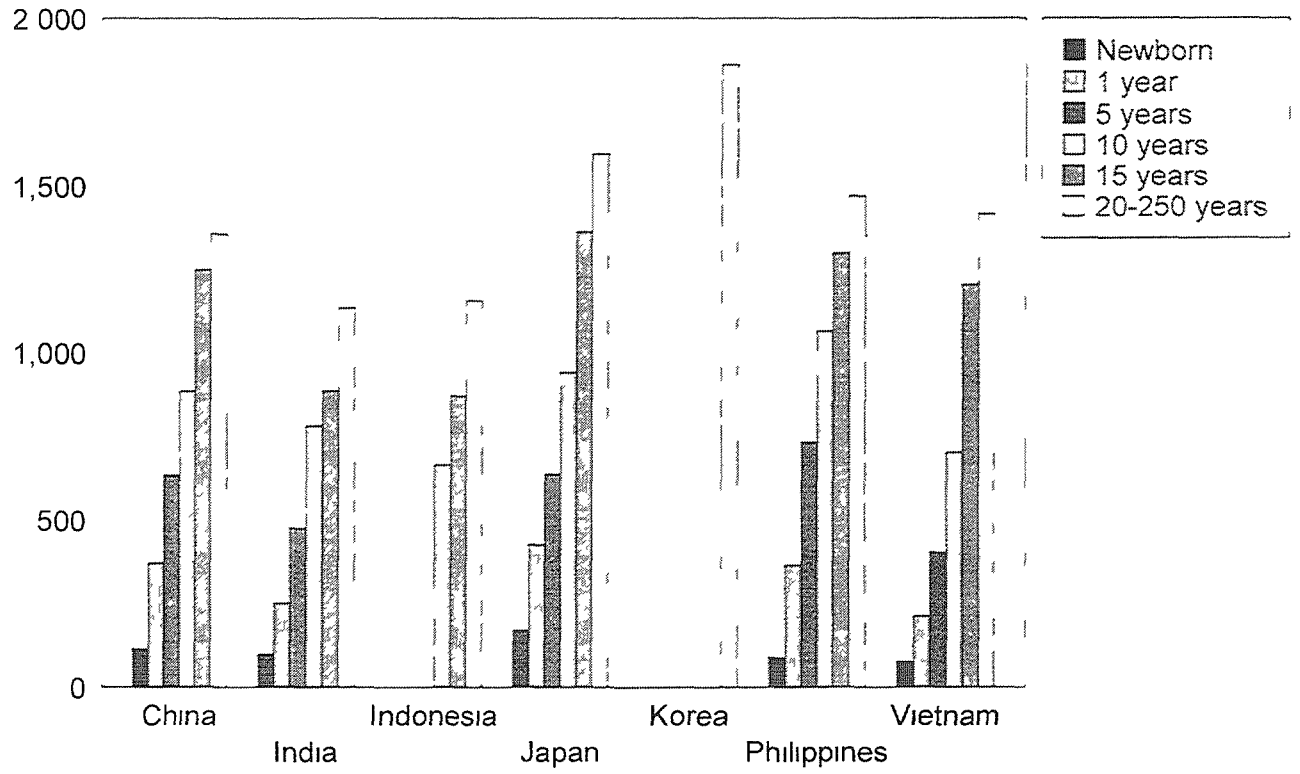


FIG 3 Male liver mass — grams

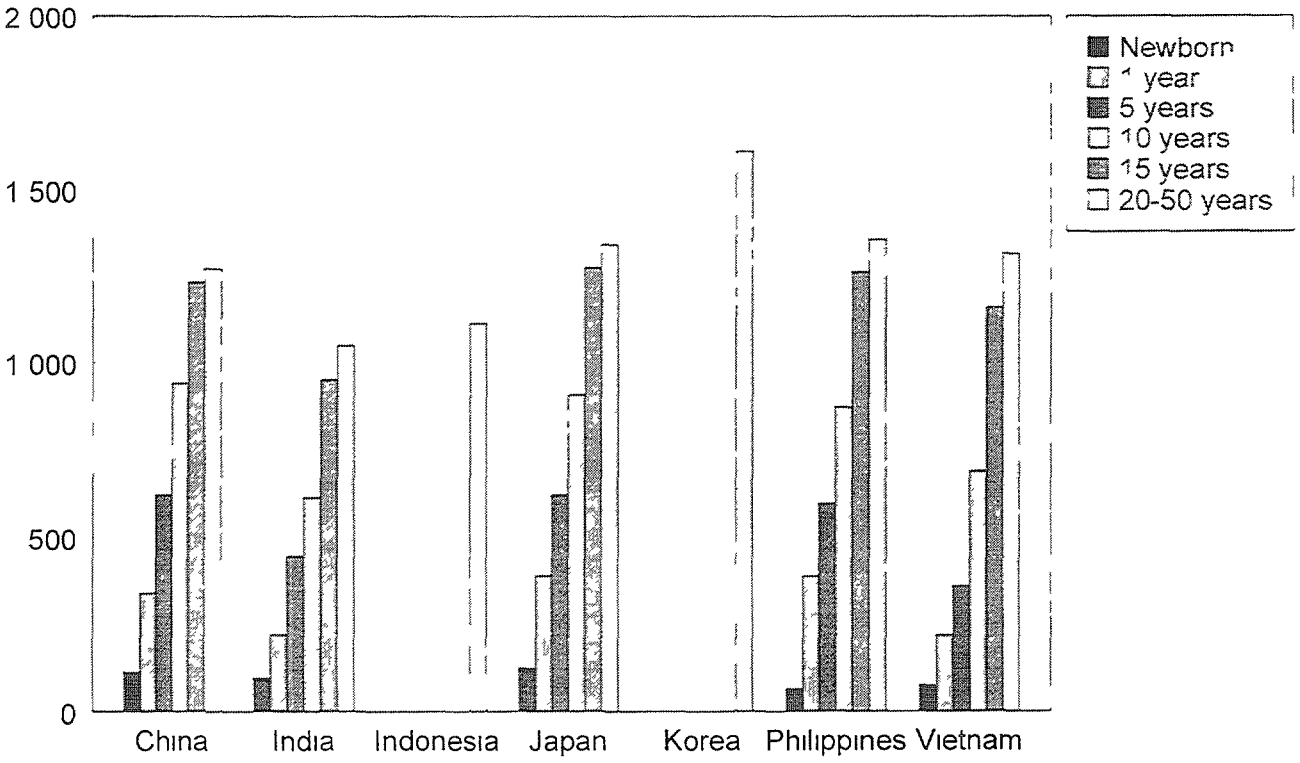


FIG 4 Female liver mass — grams

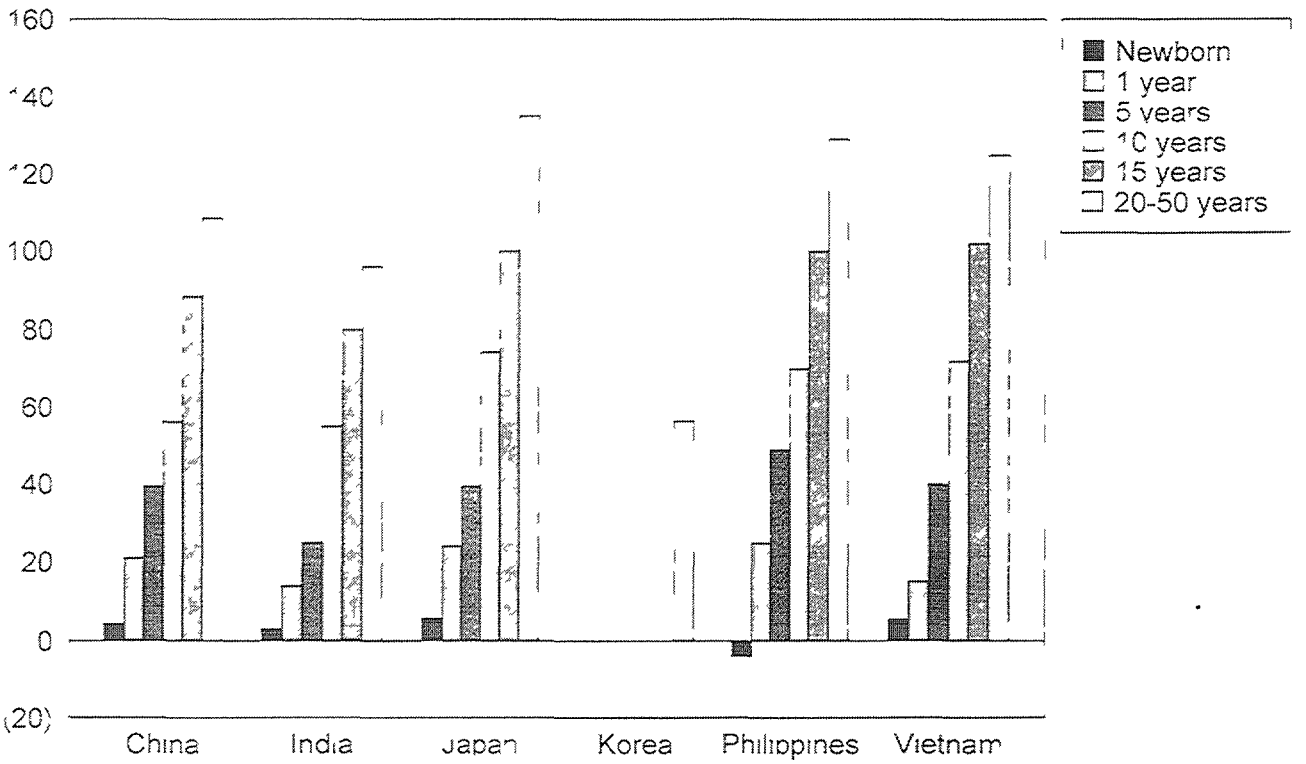


FIG 5 Male pancreas mass — grams

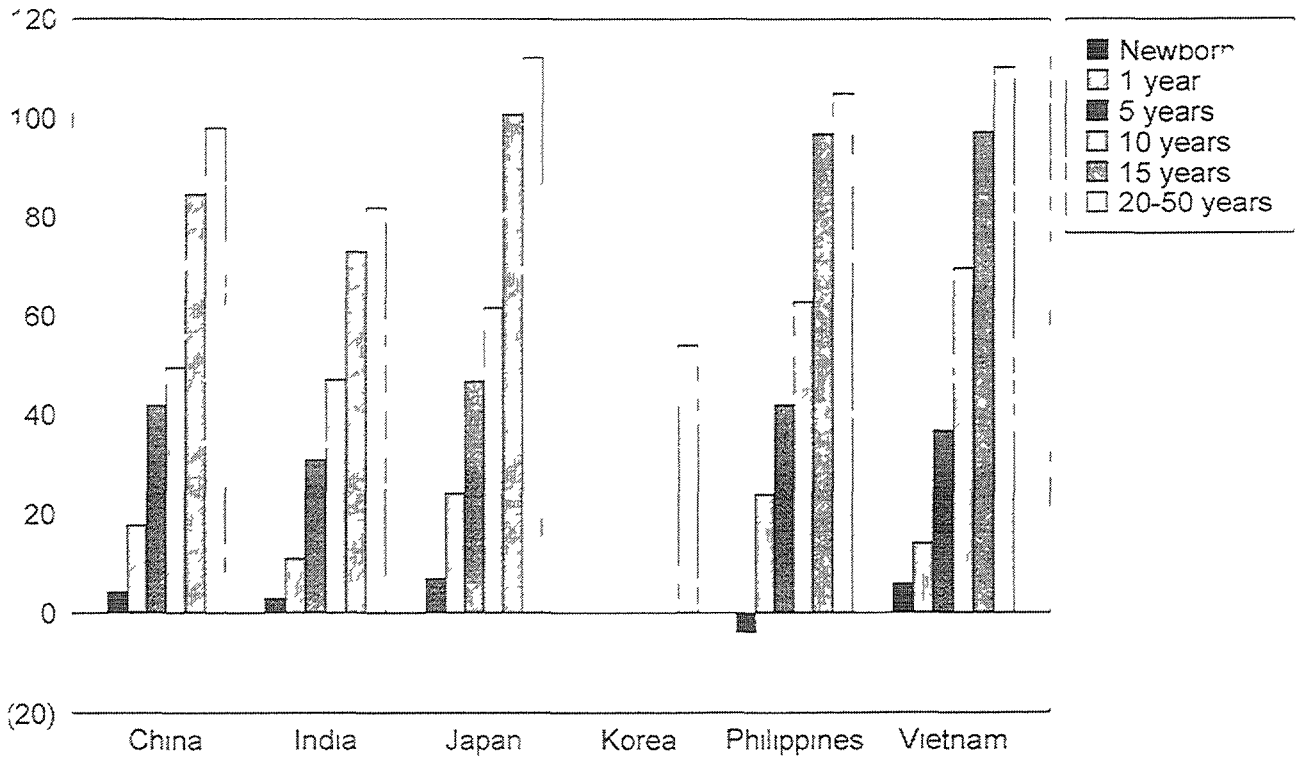


FIG 6 Female pancreas mass — grams

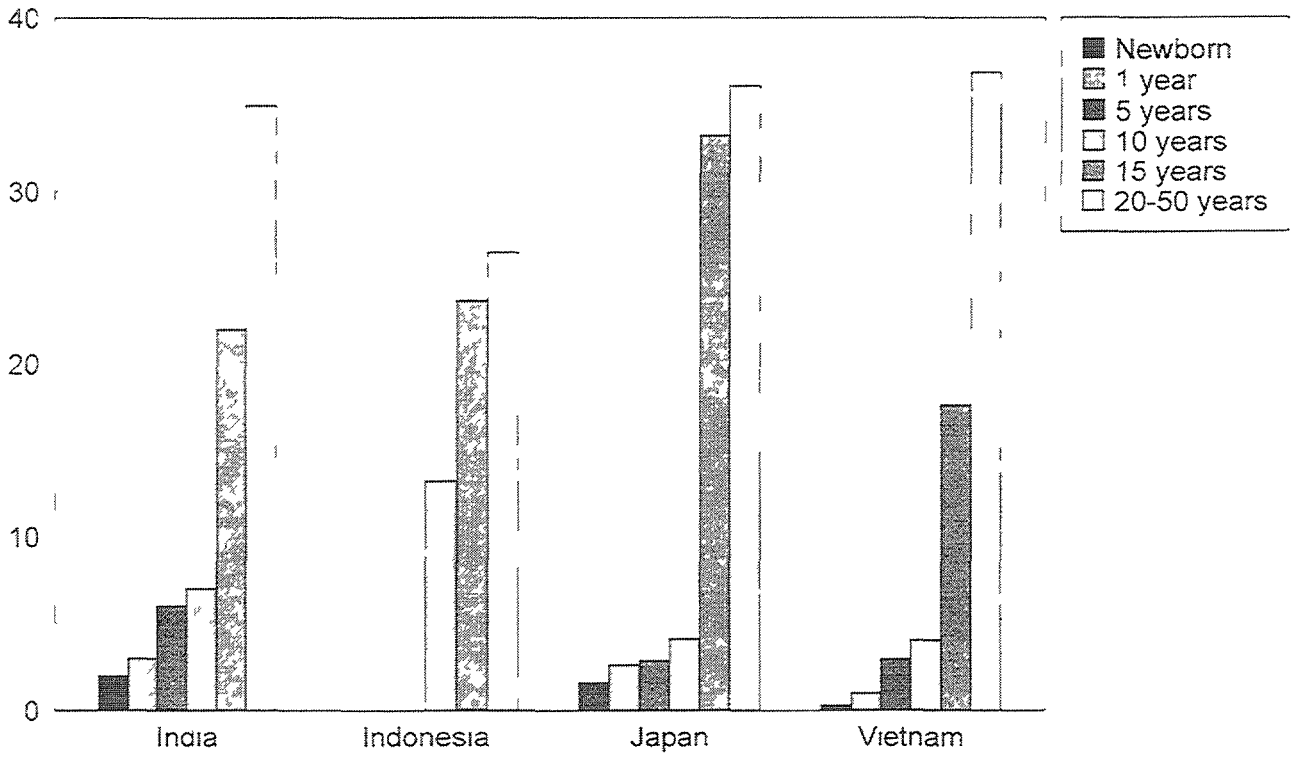


FIG 7 Testis mass — grams

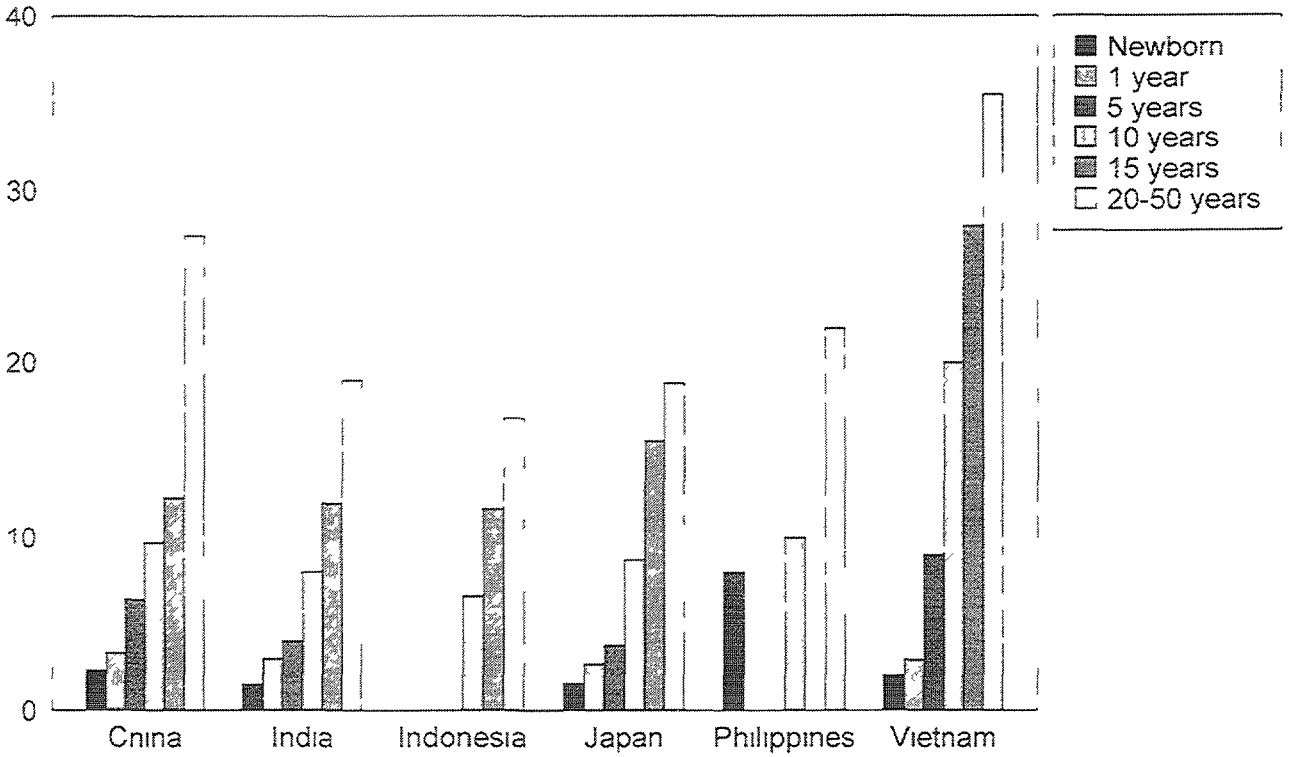


FIG 8 Male thyroid mass — grams

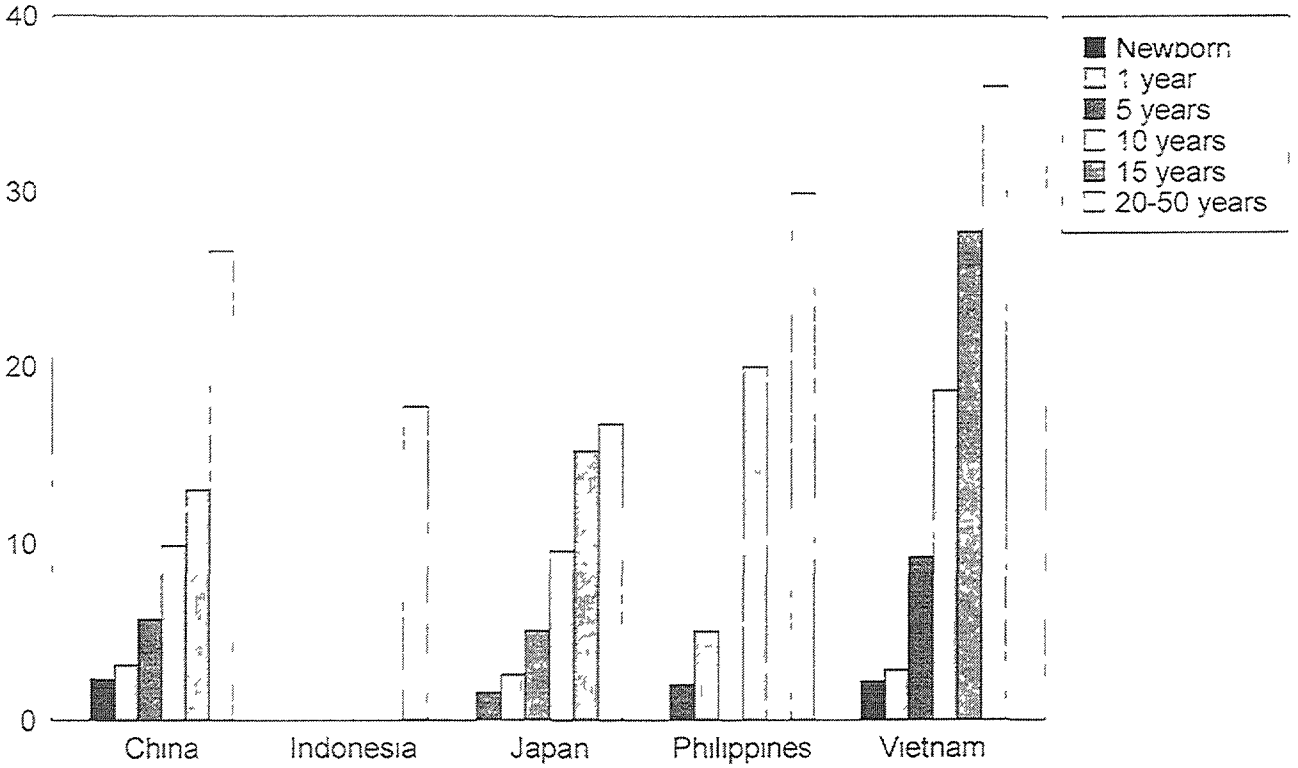


FIG. 9 Female thyroid mass — grams.

In the adult female, the heart weight ranged from 211 g (India) to 310 g (Japan), the mean being 261±41 g. This was about 60 g smaller than that of the Tanaka Model adult female (322 g) and 21 g larger than the ICRP Reference Woman (240 g).

Kidney

The data show that the weight of the kidney, as in Table 5, gradually increases with age. Growth patterns appeared roughly similar for the countries while male growth from 15 years to the adult male varied from country to country.

The combined mass of the kidneys in the adult male showed a range 207 g (Indonesia) to 324 g (Japan) with a mean of 268±42 g. This is about 50 g smaller than that for Tanaka Model (320 g) which is similar to that for ICRP Reference Man (310 g).

In the female, the kidney weight ranged from 192 g (Indonesia) to 293 g (Philippines) with a mean of 248 ± 39 g, which is about 34 g smaller than the Tanaka Model, and about 27 g smaller than the ICRP Reference Woman (275 g).

Liver

As shown in Table 6 and Figs 3-4, the liver weight increases gradually with age and the growth patterns appeared generally similar for the countries as seen from the reported data. Mass of the adult male liver ranges from 1135 g (India) to 1864 g (Republic of Korea) with a mean 1429±254 g. This is about 170 g smaller than 1600 g of the Tanaka model, which is in turn 200 g less than that of the ICRP Reference Man, 1800 g.

In the adult female, it was found to be from 1051 g (India) to 1611 g (Republic of Korea) with a mean of 1296±183 g, which is about 72 g smaller than in the Tanaka Model (1368 g) and 104 g smaller than in the ICRP Reference Woman (1400 g).

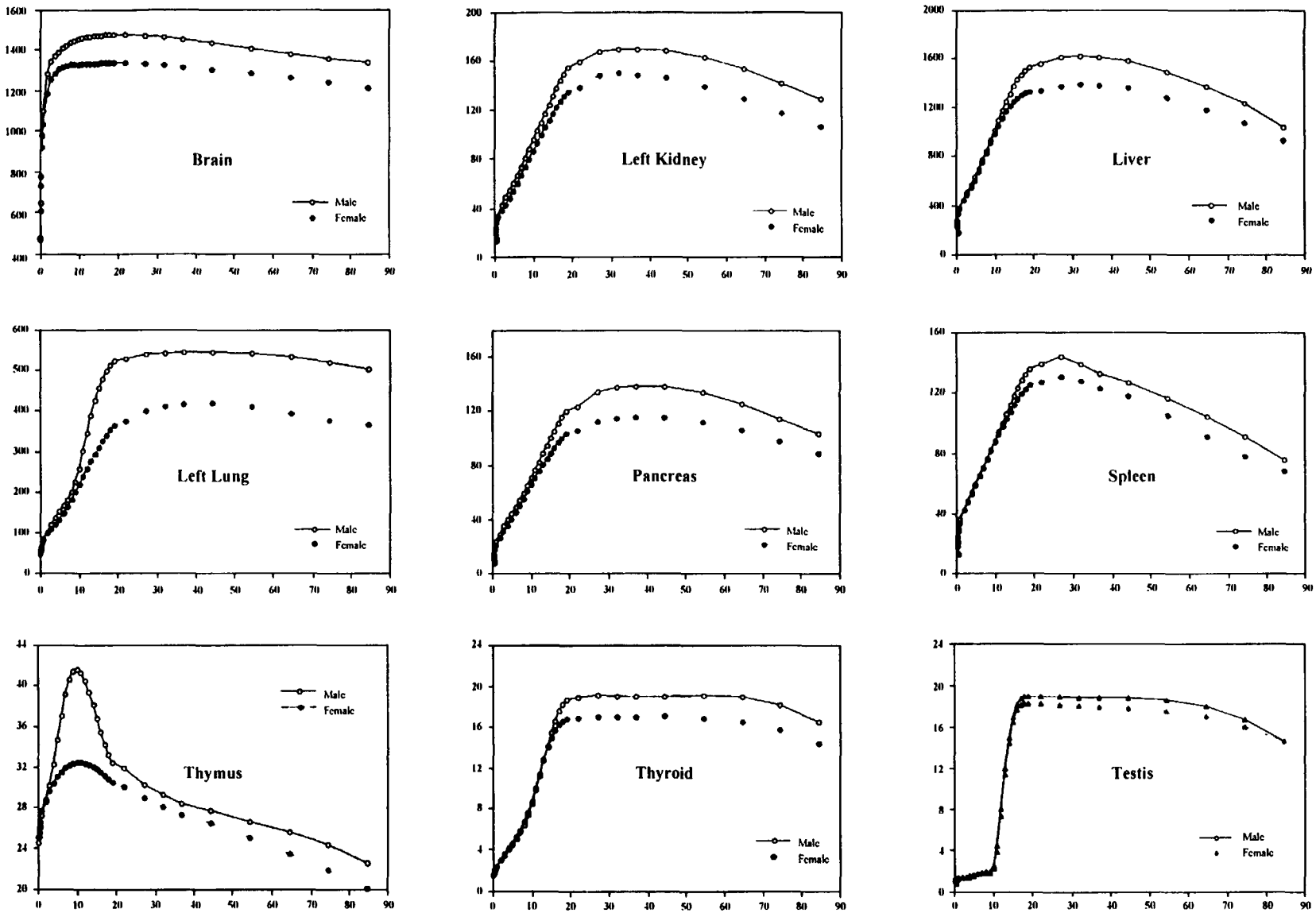


FIG. 10. Masses for selected organs for Japanese as a function of age — g [12].

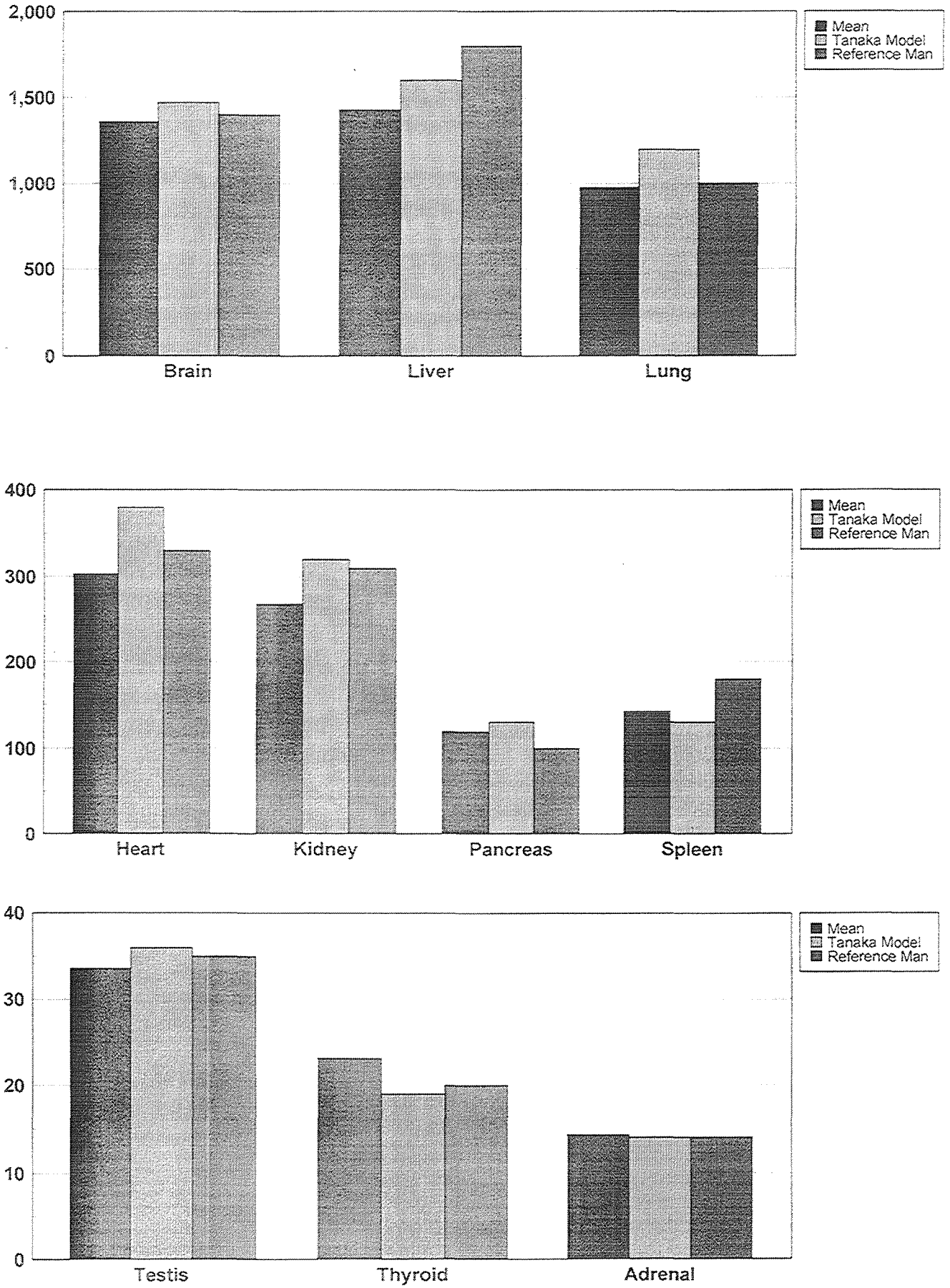
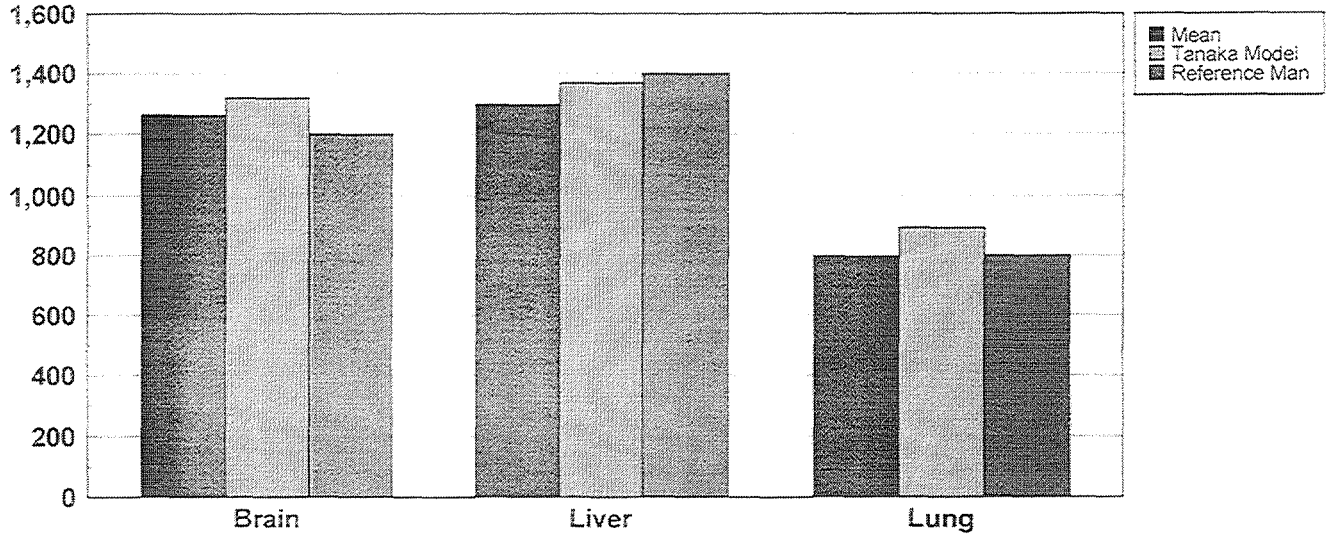
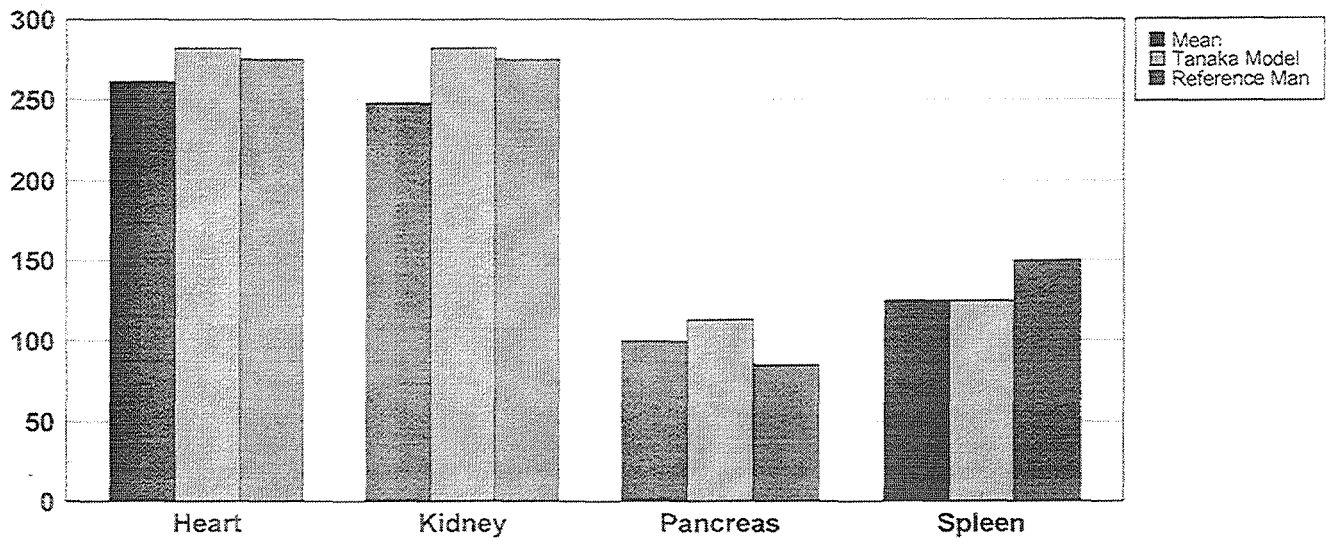


FIG. 11. Adult male organ masses.





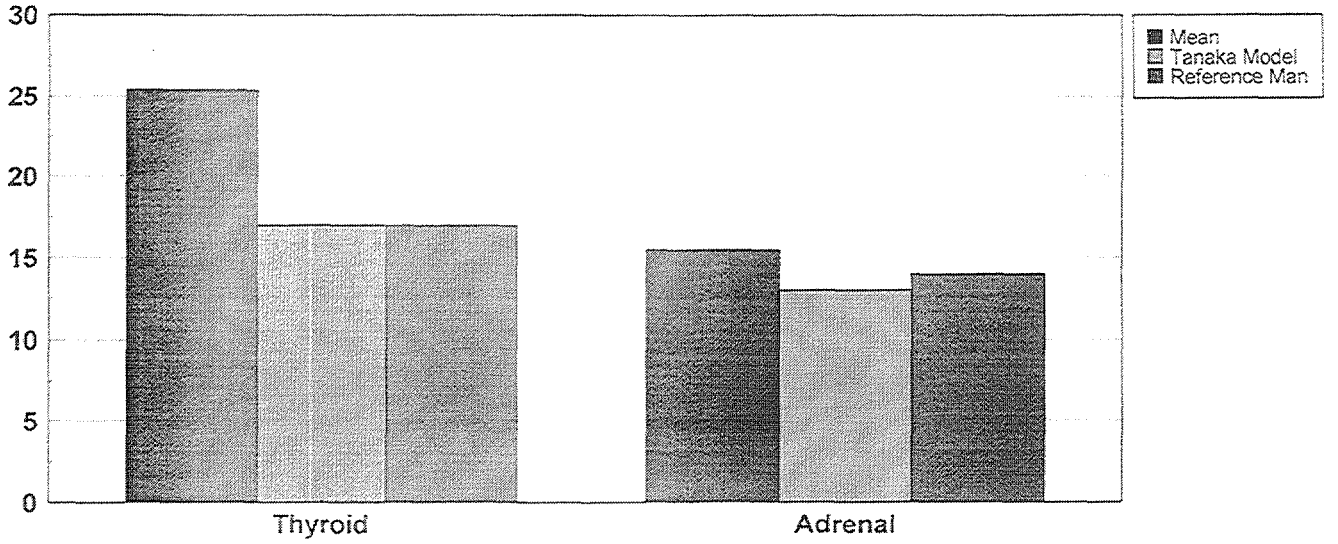


FIG. 12. Adult female organ masses.

TABLE III. BRAIN MASS - GRAMS

		China (1)		India		Indonesia (2,3)		Japan		Philippines (4)		Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean		Mean	S D	Mean	S D	Mean	S D
Male	Newborn	398 0	408 0	295	138			475 0	102 3	(1020)	-	335 63	22 07
	1y	1024 6	1035 9	785	133			1133 5	113 3	1125	83	901 20	67 84
	5y	1293 8	1312 5	986	230			1403 3	93 2	1283	85	1157 60	77 74
	10y	1388 0	1392 0	1142	182	1387 5		1447 1	84 0	1317	120	1170 71	77 36
	15y	1446 6	1441 1	1208	172	1356 0		1475 0	101 7	1357	121	1294 07	80 59
	20-50y	1432 9	(143 0)	1236	127	1345 1		1442 1	116 6	1387	143	1320 90	79 70
Female	Newborn	415 6	554 2	295	138			467 5	124 8	-		335 57	24 17
	1y	950 7	964 0	670	215			1060 3	137 3	1027	62	900 00	58 31
	5y	1182 5	1194 2	1010	220			1358 6	90 4	1250	-	1123 20	74 54
	10y	1300 6	1298 2	1084	182	1348 2		1301 7	104 7	1282	29	1138 89	72 50
	15y	1306 6	111 9	1150	100	-		1362 0	97 1	1330	30	1243 10	78 93
	20-50y	1317 4	(192 8)	1140	120	1202 6		1308 6	99 7	1321	115	1284 13	71 79

1) Adult mean calculated from the means and S D s for the 20, 30 and 40 year old adult
2) Sum of the means and S D s for the cerebrum, cerebellum and brain stem
3) "10y"=10-12y, "15y"=13-15y and "20y-50y"=20-39y
4) "Newborn"=<1y, "1y"=1-2y, "5y"=5-6y, "10y"=9-10y and "15y"=15-16y

TABLE IV. HEART MASS - GRAMS

		China (1)		India		Indonesia (2)		Japan		Republic of Korea	Philippines (3)		Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean	S D	Mean	S D	Mean	Mean	S D	Mean	S D
Male	Newborn	22 1	8 4	17	7			27 9	9 3		(19)	(11)	17 09	1 70
	1y	59 5	48 0	39	12			59 0	14 0		62	6	41 40	2 89
	5y	99 6	24 0	73	50			97 1	13 3		97	5	82 44	5 14
	10y	152 5	48 6	140	58	119 95	35 71	177 1	20 5		166	11	125 64	7 61
	15y	258 7	55 0	208	95	207 83	80 27	302 9	27 1		306	11	203 93	17 29
	20-50y	300 8	(54 9)	243	52	253 55	36 35	379 3	90 3	348 8	334	62	258 41	25 82
Female	Newborn	21 5	7 0	17	7			27 1	7 4		(15)	(7)	17 00	1 97
	1y	49 7	11 1	35	12			56 7	16 6		58	5	42 00	3 01
	5y	97 0	55 3	74	28			116 3	28 7		94	-	84 08	5 17
	10y	141 9	38 6	134	78	98 50		170 1			156	5	119 81	7 66
	15y	231 0	48 3	220	105			235 0	49 3		248	8	202 34	18 56
	20-50y	266 9	(52 1)	211	47	217 20	34 66	309 8	93 7	301 6	288	43	230 24	24 21

1) Adult mean calculated from the means and S D s for the 20, 30 and 40 year old adult
2) "10y"=10-12y, "15y"=13-15y and "20y-50y"=20-39y
3) "Newborn"=<1y, "1y"=1-2y, "5y"=5-6y, "10y"=9-10y and "15y"=15-16y

TABLE V KIDNEY MASS (2) - GRAMS

		China (1)		India		Indonesia (2)	Japan	Republic of Korea	Philippines (3)	Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean	Mean	Mean	Mean	Mean	S D
Male	Newborn	28 1	10 8	20	7		30 2		(15)	27 41	2 78
	1y	76 0	23 5	56	16		72 8		76	72 04	6 26
	5y	122 9	30 8	98	39		112 2		146	129 76	11 48
	10y	172 0	45 6	141	37	114 75	183 6		193	194 00	12 21
	15y	253 0	53 9	198	51	194 33	245 0		269	236 37	13 68
	20-50y	279 3	(57 5)	224	48	206 59	324 0	251 6	295	296 23	13 33
Female	Newborn	27 7	11 3	20	7		29 1		(13)	26 00	2 20
	1y	70 8	18 9	51	18		68 8		68	70 00	6 40
	5y	120 2	36 3	95	39		116 2		117	128 20	9 98
	10y	168 6	48 4	143	32	101 9	160 0		168	186 60	10 75
	15y	242 1	46 7	217	54	-	237 5		240	234 10	10 13
	20-50y	260 1	(51 4)	207	47	192 05	279 4	227 7	293	276 40	12 67

1) Adult mean calculated from the means and S D s for the 20, 30 and 40 year old adult
2) "10y"=10-12y, "15y"=13-15y and "20y-50y"=20-39y
3) "Newborn"=<1y, "1y"=1-2y, "5y"=5-6y "10y"=9-10y and "15y"=15-16y

TABLE VI LIVER MASS - GRAMS

		China (1)		India		Indonesia (2)		Japan		Republic of Korea	Philippines (3)		Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean	S D	Mean	S D	Mean	Mean	S D	Mean	S D
Male	Newborn	114 8	61 9	99	32			169 0	44 4		(89)	(58)	75 88	5 60
	1y	370 9	127 6	250	103			427 6	90 4		364	100	210 96	16 82
	5y	635 6	159 7	478	172			639 2	67 4		735	27	402 80	55 64
	10y	885 9	234 5	785	203	666 28	57 02	942 9	143 0		1064	106	705 06	76 71
	15y	1249 4	255 0	888	245	874 00	186 8	1363 8	150 7		1299	285	1204 44	107 89
	20-50y	1356 7	(233 9)	1135	251	1155 6	298 45	1598 9	354 4	1863 9	1472	232	1417 82	116 91
Female	Newborn	115 3	37 9	99	32			127 4	36 1		(66)	(31)	77 60	5 41
	1y	341 6	89 3	222	81			391 9	71 5		390	32	221 20	65 03
	5y	624 4	315 7	448	150			625 0	91 5		600	-	362 00	32 72
	10y	943 2	955 2	617	208			910 0	107 6		875	18	692 20	57 67
	15y	1233 0	273 1	954	244			1276 7	75 5		1265	15	1161 90	237 58
	20-50y	1272 4	(248 8)	1051	226	1114 7	236 91	1345 2	332 8	1610 9	1361	180	1319 00	105 70

TABLE VII. LUNG MASS (2) - GRAMS

		China (1)		India		Indonesia (2,3)	Japan (2)	Republic of Korea (2)	Philippines (2,4)	Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean	Mean	Mean	Mean	Mean	S D
Male	Newborn	61 4	22 0	63	21		90 4		(69)	39 91	4 41
	1y	207 7	167 3	123	36		193 6		216	120 60	12 52
	5y	362 0	120 4	252	137		322 9		281	212 24	15 86
	10y	564 2	228 7	462	220	309 68	554 3		515	390 18	19 79
	15y	941 6	435 3	645	242	754 50	910 0		831	643 70	22 37
	20-50y	1065 1	(329 4)	841	154	826 85	1169 8	1201 4	1049	680 06	27 30
Female	Newborn	56 5	17 8	63	21		90 4		(64)	39 11	4 02
	1y	187 1	63 9	98	30		186 0		191	119 80	26 71
	5y	354 3	124 6	208	55		255 0		318	207 20	20 52
	10y	472 6	189 7	413	198		453 4		431	325 40	20 80
	15y	769 3	232 5	598	226		641 3		735	570 30	21 17
	20-50y	842 2	(232 9)	670	140	739 16	906 8	948 4	864	607 50	26 41

1) Adult mean calculated from the means and S D s for the 20, 30 and 40 year old adult
2) Sum of the means and s d s for the left and right lobes
3) "10y"=10-12y, "15y"=13-15y and "20y-50y"=20-39y
4) "Newborn"=<1y, "1y"=1-2y, "5y"=5-6y, "10y"=9-10y and "15y"=15-16y

TABLE VIII PANCREAS MASS - GRAMS

		China (1)		India		Japan		Republic of Korea	Philippines		Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean	S D	Mean	Mean	S D	Mean	S D
Male	Newborn	4 4	3 2	3	1	5 8	2 6		(4)	(4)	5 53	2 03
	1y	21 0	30 1	14	6	24 1	7 7		25	4	15 04	4 30
	5y	39 5	14 3	25	12	39 5	7 9		49	1	40 00	8 04
	10y	56 2	20 6	55	15	74 3	14 0		70	8	72 00	12 06
	15y	88 4	25 2	80	49	100 0	20 0		100	2	102 00	17 89
	20-50y	108 5	(29 4)	96	34	135 1	37 8	56 4	129	15	124 81	21 55
Female	Newborn	4 3	2 3	3	1	7 0	2 7		(4)	(3)	5 97	1 42
	1y	17 7	7 0	11	6	24 2	5 0		24	2	14 12	3 87
	5y	41 8	55 1	31	13	46 7	8 6		42	-	36 84	6 31
	10y	49 4	15 3	47	15	61 7	4 1		63	1	69 81	9 75
	15y	84 8	31 2	73	25	100 8	6 1		97	2	97 41	21 16
	20-50y	98 1	(28 0)	82	32	112 2	30 4	54 0	105	5	110 30	22 01

1) Adult mean calculated from the means and S D s for the 20, 30 and 40 year old adult

TABLE IX PITUITARY GLAND MASS - GRAMS

		Japan		Viet Nam	
Sex	Age	Mean	S D	Mean	S D
Male	Newborn	0 19	0 08	0 10	0 01
	1y	0 21	0 08	0 14	0 01
	5y	0 32	0 06	0 25	0 05
	10y	0 36	0 07	0 34	0 09
	15y	0 53	0 08	0 48	0 14
	20-50y	0 56	0 12	0 60	0 12
Female	Newborn	0 20	0 07	0 11	0 02
	1y	0 27	0 06	0 15	0 02
	5y	0 31	0 08	0 25	0 05
	10y	0 36	0 08	0 36	0 06
	15y	0 57	0 08	0 55	0 11
	20-50y	0 63	0 15	0 60	0 11

TABLE X SPLEEN MASS - GRAMS

		China (1)		India		Indonesia (2)		Japan		Republic of Korea	Philippines (3)		Viet Nam	
Sex	Age	Mean	S D	Mean	S D	Mean	S D	Mean	S D	Mean	Mean	S D	Mean	S D
Male	Newborn	11 9	8 1	7	4			12 5	4 7		(7)	(7)	8 03	1 33
	1y	45 1	22 9	23	13			45 9	17 7		47	2	25 88	5 09
	5y	78 9	75 4	58	31			61 7	18 6		66	1	46 92	12 01
	10y	106 7	49 0	102	55	73 13	17 39	91 1	21 7		88	7	87 92	17 52
	15y	161 7	73 3	118	28	83 75	37 12	120 8	18 4		124	3	149 56	28 64
	20-50y	167 1	(80 3)	137	67	112 71	56 76	129 8	54 2	67 3	138	18	165 74	38 68
Female	Newborn	11 3	5 7	7	4			12 6	4 6		(7)	(6)	8 03	1 30
	1y	39 7	17 2	21	8			36 7	11 2		33	15	25 19	6 40
	5y	65 3	28 4	58	23			52 9	13 7		65	-	41 76	10 19
	10y	94 4	44 0	89	62			85 1	31 6		75	4	85 93	19 16
	15y	150 6	67 5	132	44			113 1	22 4		110	-	137 24	21 45
	20-50y	146 5	(61 5)	119	59	104 23	28 30	123 1	53 6	58 2	120	14	139 68	26 71

1) Adult mean calculated from the means and S D s for the 20 30 and 40 year old adult
2) "10y' =10-12y "15y"=13-15y and "20y-50y"=20-39y
3) "Newborn"=<1y "1y"=1-2y "5y"=5-6y '10y"=9-10y and "15y"=15-16y

TABLE XI TESTIS MASS (2) - GRAMS

	India		Indonesia (1 2)	Japan (1)	Viet Nam	
Age	Mean	S D	Mean	Mean	Mean	S D
Newborn	2	1		1 64	0 35	0 11
1y	3	1		2 64	1 03	0 52
5y	6	3		2 87	2 96	1 12
10y	7	2	13 25	4 09	4 02	1 72
15y	22	5	23 66	33 29	17 67	3 36
20-50y	35	5	26 44	36 11	36 86	4 44

1) Sum of the means and s d s for the left and right lobes
2) "10y"=10-12y "15y"=13-15y and "20y-50y"=20-39y

TABLE XII THYMUS MASS - GRAMS

		Japan		Viet Nam	
Sex	Age	Mean	S D	Mean	S D
Male	Newborn	17 6	8 4	13 06	2 19
	1y	30 1	8 2	20 00	3 08
	5y	30 9	9 5	20 04	3 63
	10y	39 7	9 3	15 00	2 92
	15y	35 1	12 7	14 93	3 15
	20-50y	32 2	16 4	10 00	2 21
Female	Newborn	18 8	8 5	11 97	2 14
	1y	28 1	8 2	19 92	3 05
	5y	33 8	8 5	18 08	3 20
	10y	34 0	5 3	15 07	3 04
	15y	30 7	5 8	14 97	3 25
	20-50y	27 5	12 0	7 97	2 23

TABLE XIII THYROID GLAND MASS (2) - GRAMS

		China	80% normal	India		Indonesia		Japan		Philippines		Viet Nam	
Sex	Age	Mean	Range	Mean	S D	Mean	S D	Mean	S D	Mean	S D	Mean	S D
Male	Newborn	2 3	1 1-3 9	1 5	0 4			1 58	0 56	(8)	-	2 02	0 27
	1y	3 3	1 7-5 3	3	1 0			2 70	0 71	-	-	2 95	0 36
	5y	6 4	3 1-10 2	4	2 0			3 77	0 58	-	-	9 00	1 50
	10y	9 7	4 9-16 2	8	3 0	6 58	3 72	8 71	1 13	10	-	20 03	2 73
	15y	12 3	7 0-19 9	12	5 0	11 67	5 51	15 51	2 41	-	10	27 99	3 42
	20-50y	27 4	10 7-55 8	19	7 0	16 81	6 85	18 80	5 13	22	-	35 47	4 31
Female	Newborn	2 3	1 1-4 3					1 57	0 47	(2)	-	2 17	0 35
	1y	3 1	1 6-5 1					2 56	0 72	5	-	2 82	0 32
	5y	5 7	3 4-8 7					5 04	0 77	-	-	9 23	2 38
	10y	9 9	5 0-16 5					9 58	3 54	20	-	18 67	3 02
	15y	13 1	7 6-19 5					15 30	3 02	-	-	27 75	3 56
	20-50y	26 6	10 1-33 5			17 76	6 15	16 80	4 86	30	8	36 00	3 31

TABLE XIV ADRENAL GLAND MASS (2) - GRAMS

		China		Indonesia	Japan	Philippines
Sex	Age	Mean	S D	Mean	Mean	Mean
Male	Newborn	7 3	3 3		4 34	
	1y	5 2	2 2		4 53	
	5y	7 5	4 1		5 30	
	10y	9 8	4 8	5 38	8 79	20
	15y	12 6	4 5	8 50	10 91	
	20-50y	14 7	5 7	11 30	14 29	17
Female	Newborn	7 2	3 2		3 65	
	1y	5 4	2 8		4 08	
	5y	7 3	3 9		5 58	
	10y	10 0	4 7		8 10	
	15y	14 2	5 3		10 63	
	20-50y	14 3	6 2	9 67	12 91	25

TABLE XV MALE ADULT ORGAN MASSES (7 COUNTRIES)

Organ	No of countries	Range		Mean	S D	Mid point (1)	Tanaka Model adult male	Reference Man ICRP Pub 23
		Min	Max					
Brain	6	1,236	1,442	1,361	77		1,470	1,400
Heart	7	243	379	303	53	310	380	330
Kidney (2)	7	224	324	268	42		320	310
Liver	7	1,135	1,864	1,429	254	1,502	1,600	1,800
Lung (2)	7	680	1,201	976	196	945	1,200	1 000
Pancreas	6	96	135	119	16		130	100
Pituitary	2	0 56	0 60	0 58	-		0 6	0 6
Spleen	6	113	167	142	21		130	180
Testis (2)	4	26 4	36 9	33 6	1 8		36	35
Thymus	2	10 0	32 2	21 1	-		32	20
Thyroid	6	16 8	35 5	32 2 (JPN)	16 4 (JPN)		19	20
Adrenal (2)	4	11 3	17	14 3	2 3		14	14
Gall bladder	1	-	-	29 (PHI)	18 (PHI)		(8) *	10
Prostate	1	-	-	19 1 (IDN)	10 9 (IDN)		(13)	16
Salivary gland	1	-	-	78 5 (IDN)	14 9 (IDN)		(82)	85

1) Ref 17
*) Figures in parentheses are estimates

TABLE XVI FEMALE ADULT ORGAN MASSES (7 COUNTRIES)

Organ	No of countries	Range		Mean	S D	Tanaka Model adult female	Reference Man ICRP Pub 23
		Min	Max				
Brain	6	1,140	1,321	1,262	74	1,320	1,200
Breast	1	-	-	250 (VIE)	45 (VIE)	(300) *	360
Heart	7	211	310	261	41	322	240
Kidney (2)	7	192	293	248	39	282	275
Liver	7	1,051	1,361	1,296	183	1,368	1,400
Lung (2)	7	608	948	797	127	894	800
Ovary	1	-	-	9 0 (VIE)	1 0 (VIE)	(11)	11
Pancreas	6	82	112	100	12	113	85
Pituitary	2	0 60	0 63	0 62	-	0 64	0 7
Spleen	6	119	147	125	15	125	150
Thymus	2	7 97	27 5	27 5 (JPN)	12 0 (JPN)	29	20
Thyroid	6	16 8	36 0	25 4	8 2	17	17
Adrenal (2)	4	9 7	25	15 5	6 6	13	14
Uterus	1	-	-	58 5 (PHI)	29 9 (PHI)	(70)	80
Gall bladder	1	-	-	40 (PHI)	7 (PHI)	(6)	8
Salivary gland	1	-	-	65 8 (IDN)	19 4 (IDN)	(62)	70

*) Figures in parentheses are estimates

Lung

The lung mass grows gradually with age (Table 7) with similar patterns of increase seen for all the participating countries. The weight of the both lungs in the adult male for the seven countries was from 680 g (Viet Nam) to 1201 g (Republic of Korea) with a mean of 976±196 g. A relatively large variation was found (RSD 20.1%). The mean is approximately 220 g or 19% smaller than that of Tanaka Model, 1200 g but is only a little smaller than 1000 g in the ICRP Reference Man.

In the female counterpart, it ranged from 608 g (Viet Nam) to 948 g (Republic of Korea) with a mean of 797±127 g (RSD 15.9%). This is about 11% less than the Tanaka Model (894 g), and almost the same as that of the ICRP Reference Woman (800 g).

Pancreas

The mass of the pancreas increases with age with similar growth patterns for the reporting countries (Table 8 and Fig. 5-6). The mass in the adult male ranged from 96 g (India) to 135 g (Japan) with a mean 119±16 g. This was about 11 g less than that for the Tanaka Model, and 19 g larger than the ICRP Reference Man.

In the adult female, it ranged from 82 g (India) to 112 g (Japan) and the mean was 100±12 g. It was about 13 g less than in the Tanaka Model, but, 15 g larger than the ICRP Reference Woman.

The Korean results were not used in the calculated means because they were about one half of the other participants' values. However, another source indicates 85.5 and 89.7 g, for their adult female and male, respectively [Ref. 9, Table 9-10].

Pituitary gland

The pituitary gland is a small organ of less than 1 g (Table 9). It grows with age and stays almost constant in the adult male and female up to age 50. The data was obtained only from Japan and Viet Nam. It is only the organ that is larger in the female than in the male [2, 12].

In the adult male, the mean 0.58 g is close to that assumed in Tanaka Model 0.60 g, which is the same as that in the Reference Man. In the adult female, the mean was 0.62 g and a little smaller than the Tanaka Model, and ICRP Reference Woman, 0.64 and 0.70 g, respectively.

Spleen

The spleen mass shows gradual increase with age, while, according to Japanese data, tends to exhibit considerable decrease beyond after the 30s, both in the male and female (Table 10). In the adult male, the weight ranged from 113 g (Indonesia) to 167 g (China), with a mean of 142±21 g, which is 12 g larger than for the Tanaka Model (130 g). It was 38 g smaller than for the ICRP Reference Man (180 g). The spleen weight may increase due to a certain disease [14].

In the adult female, it ranged from 104 g (Indonesia) to 147 g (China) with the mean 125±15 g. This was the same as that of the Tanaka Model and 25 g smaller than the ICRP Reference Woman.

The Korean results were not used in calculating means because they were about a half of the rest of the data, but, the other data source shows approximately 100 and 107 g for the female and male, respectively [Ref. 9, Table 9-10].

Testis

As shown in Table 11 and Fig. 7, the weight of testes increases very slowly until 10 years and showed a spurt between 10 and 15 years. The spurt appeared most conspicuous for Japanese, followed by the Indians and the Viet Namese.

The testes weight in the adult ranged from 26.4 (Indonesia) to 36.9 g (Viet Nam) with a mean of 33.6±1.8 g (RSD: 5.4%). The mean mass is consistent, within -6.7%, with the value of the Tanaka Model for Asian adult male and ICRP Reference Man, 36 and 35 g, respectively.

Thymus

It is known that the thymus shows a peculiar growth pattern - rapid growth up to around 10 or 12 years and decrease thereafter [2], as also seen for Japanese [12]. Data was reported only from Japan and Viet Nam (Table 12).

The thymus weights from Viet Nam are generally smaller that those for Japanese children and particularly adult male (about a third: 10 to 32.2 g in the adult male). The mass of the Tanaka Model is 32g.

In the adult female, the data from Japan was 27.5g, compared with 29 g in the Tanaka Model. The value reported from Viet Nam was about 8 g. The thymus weight of the ICRP Reference male and female is the same, 20 g.

Thyroid gland

As shown in Table 13 and Figs 8-9, the thyroid gland showed an increase with age, with acceleration in the teens. The value was then constant past age 60. The increase after birth to 17 years has been pointed out to be an important factor in assessing dose from radioiodine deposited in the organ.

The thyroid weight of the adult male has a wide range from 16.8 g (Indonesia) to 35.5g (Viet Nam), and appeared in the following order: Viet Nam > China > Philippines > India > Japan > Indonesia. This may be associated with possible occurrence of goiter due to low intakes of natural iodine in the diet. It is known that goiters are seen in Viet Nam [15]. The mean value 23.2±7.0 g (RSD 30.2%) is considerably larger than the value for the Tanaka Model and the ICRP Reference Man, 19 g and 20 g, respectively.

The thyroid weight in the adult female was from 16.8 g (Japan) to 36.0 g (Viet Nam) with a mean of 25.4±8.2 g (RSD 32.3%). No data was available from India. The mean is markedly larger than those in the Tanaka Model and ICRP Reference Woman, 17 and 17 g, respectively.

Adrenal gland, gall bladder, prostate and uterus

The adrenal weight increases with age. In the adult, it changes little up to the 50s and 60s according to the Japanese data (Table 14). The adrenal mass in the adult male ranges from 11.3 (Indonesia) to 17 g (Philippines) with a mean 14.3 g which is in agreement with that of the Tanaka Model and ICRP Reference Man, 14 g. In the adult female, it ranged from 9.7 g (Indonesia) to 25 g (Philippines) and the mean being 15.5±6.6 g. This was 19% larger than the Tanaka Model and 11% larger than the ICRP Reference Woman.

The gall bladder was reported only from Philippines. The average weights for the adult appeared a few times larger than those assumed by ICRP.

The weights of the prostate (19.1 g) and salivary glands (78.5 and 65.8 g for the male and female adult, respectively) are reported only from Indonesia and regarded to be valuable (Tables 15-16).

Summary of Average Adult Organ weights

Male

The total mean of the brain mass, 1361 g had small variation among six countries (RSD 5.7%) and 93 and 97% of the ICRP Reference Man and Tanaka Model adult male, respectively (Fig. 11).

The average weights of the heart, kidney, liver and lung were lower than that of the ICRP Reference Man, being 92, 87, 79 and 98%, respectively. These were 80, 84, 89 and 81% of the Tanaka Model for Asian adult male, respectively. The weights of the pancreas, thymus and thyroid were larger than those of the Reference Man, being 119, 161 and 116%, respectively. These were 92, 100 and 122% of that of the Tanaka model, respectively. That of the pituitary, testis and adrenal was 97, 96 and 102%, of that of the Reference Man, respectively, while it was being 97, 93 and 102% of that of the Tanaka Model. The spleen weight was 79 and 109% of that of the Reference Man and Tanaka Model, respectively.

For information, the weight of the prostate and salivary glands reported was 119 and 92% of that of the ICRP Reference Man, respectively.

Female

The mean brain mass was 1262 g (RSD 5.9%) and 96 and 105% of that for the Tanaka Model and Reference Woman of ICRP (Fig. 12).

The average weight of the heart, kidney, liver and lung was 109, 90, 93 and 100% of that of the ICRP Reference Woman, respectively. That was 81, 88, 95 and 89% of that of the Tanaka Model for Asian adult female, respectively. The weight of the breast and ovary reported was 69 and 82% of that of the Reference Woman, respectively and 83 and 82% of that of the Tanaka Model, respectively. The weight of the pancreas, thymus and thyroid was 118, 138 and 149%, respectively of the Reference Woman. It was 88, 95 and 149% of that of the Tanaka Model, respectively. The average weight of the pituitary and adrenal was 89 and 111%, respectively of that of the ICRP Reference Woman and 97 and 119% of the Tanaka Model for Asian adult female. The spleen weight was 83 and 100% of the Reference Woman and Tanaka Model, respectively.

For information, the weight reported for the uterus and salivary glands was 73 and 94% of the Reference Woman and 84 and 106% of the Tanaka Model, respectively.

Fractional mass of organs

The fraction of total body mass represented by each organ, assumed to have been obtained for individual subjects, are averaged over each age group in Tables 17-18. Significance of the data lies in that they are the ratios of the individual organs to the total body weight in individual subjects, and that the values can be regarded to be normalized with respect to the body weight, providing that the data were properly obtained. The data may be useful in understanding organ masses among different populations. However, the following factors should be noted for nature of the fractional mass data:

(1) the weight of cadaver might be affected by dehydration after death, and
(2) the body weight is the sum of the lean body mass and body lipid (fat), and may be influenced by varying degree of obesity in the adult.

The pattern of change in the fractional mass of organs during growth from the newborn to adult (20-50y) is summarized in Table 19. However, the patterns do not indicate changes between 20 and 50 years. Variations in the fractional mass with age for the brain, liver, spleen and thyroid are shown in Figs. 13-18.

The average fractional organ masses

The mean fractional masses calculated from Chinese, Indian and Japanese data for 12 organs in the adult male and 11 in the female are shown in Tables 20-21. The data for the adrenals from China were not used in the calculation. Fractional masses calculated from the Tanaka Model [13] and ICRP Reference Man data [2] are presented for comparison. Fractional organ masses for Indonesia, Philippines and Viet Nam were estimated using the average body mass values for the adult male and female, and are shown in the tables. From these tables, the following can be seen:

(1) The fractional mass for most of the organs currently reported from China, India and Japan appears to be similar.
(2) Estimated fractional organ masses from the Philippine data are relatively close to the mean fractions reported from the three countries. For the Indonesian estimates, the fractional mass for organs except brain seemed to be smaller than mean fractions from China, India and Japan. For Viet Nam, the estimates for kidney, spleen and thyroid appeared larger than the three country-means.
(3) The fractional mass of the brain in the adult male and female appeared to be nearly constant, 0.025-0.027 among the three country-means, estimates for other three countries and the Tanaka Model adult male. It was considerably larger than 0.020-0.021 of the ICRP Reference Man and Woman.
(4) The data shows that the fractional organ mass may vary from population to population, especially between the present Asian and the European populations (including North Americans) as recommended by ICRP.

Comparison of fractional organ mass with Tanaka Model and ICRP Reference Man data

In Fig. 19 are shown ratios between the total mean of the fractional organ masses (China, India and Japan) and the Tanaka Model or the ICRP Reference Man data.

Male

With reference to the Tanaka Model adult male, most of the organs showed ratios near unity (brain, kidney, liver, lung, pancreas, pituitary gland, testes, thymus, adrenals: 0.90-1.13) where the spleen, thyroid and heart, showed somewhat high or low ratios: 1.27, 1.28 and 0.89, respectively (Fig. 19).

In comparison with ICRP Reference Man, many organs showed larger values than unity (brain, heart, lung, pancreas, testes, thymus, thyroid, adrenals: 1.25-1.93). Among them, the brain, pancreas, testis, thymus and thyroid were organs to have ratios larger than 1.30. However, for the heart, liver, pituitary and spleen, the three country means were within 0.96-1.11 of the Reference Man.

Female

In comparison with the Tanaka Model adult female, eight organs had ratios near unity (brain, kidney, liver, lung, pancreas, pituitary, thymus, adrenals: 0.91-1.04) while the spleen, thyroid and heart show slightly different ratios: 1.16, 1.12 and 0.86, respectively (Fig. 19).

Compared with ICRP Reference Woman, however, the present ratios tended to be higher for nine organs (brain, heart, kidney, lung, pancreas, spleen, thymus, thyroid and adrenal: 1.12-1.59). Among them, the brain, heart, pancreas, thymus and thyroid have ratios greater than 1.24. However, for the liver and pituitary, the ratio was 1.04 and 1.00, respectively.

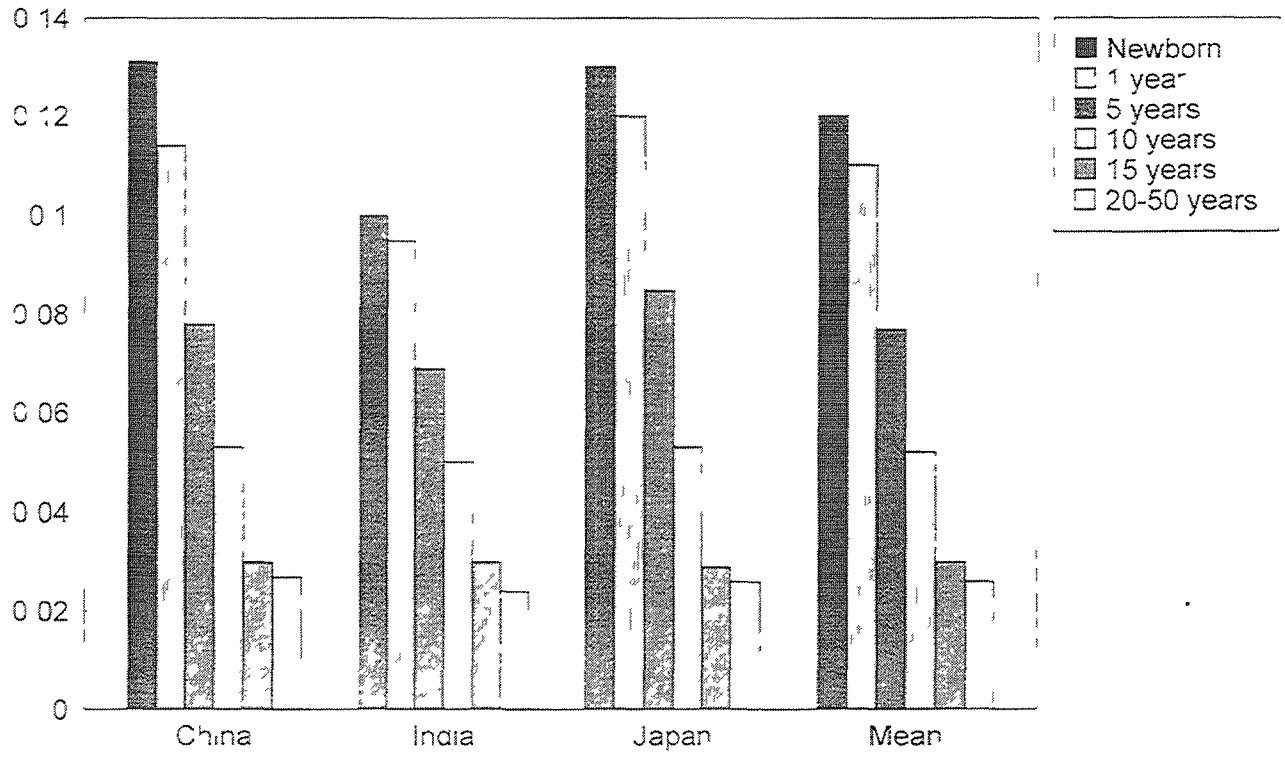


FIG 13 Body mass fraction for brain — Male

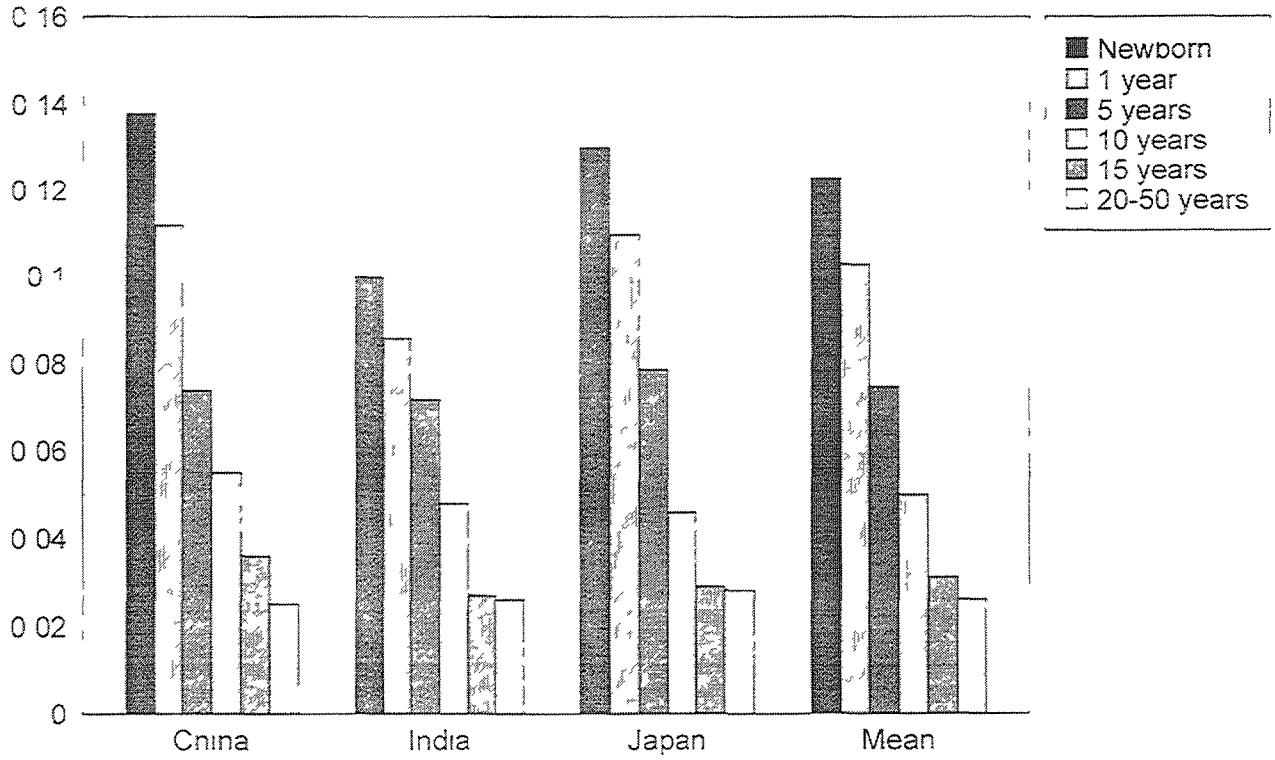


FIG 14 Body mass fraction for brain — Female

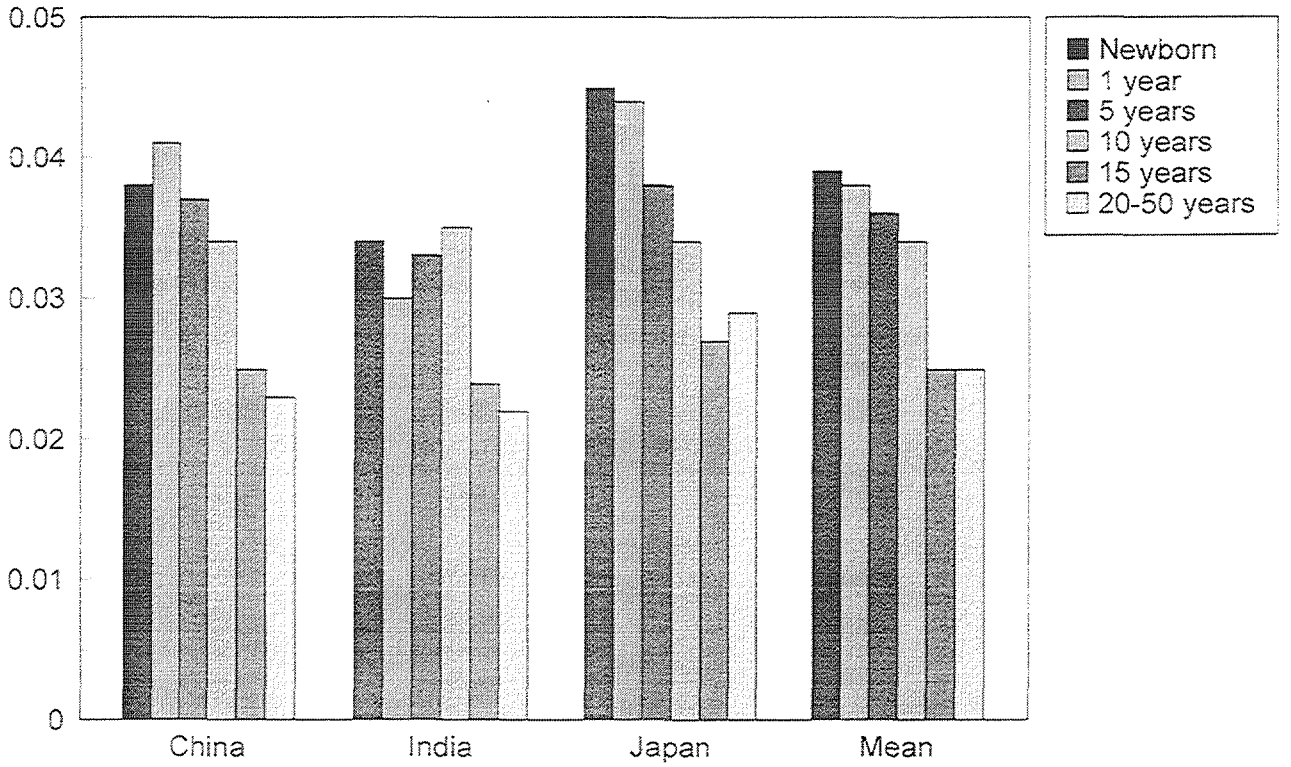


FIG. 15. Body mass fraction for liver — Male.

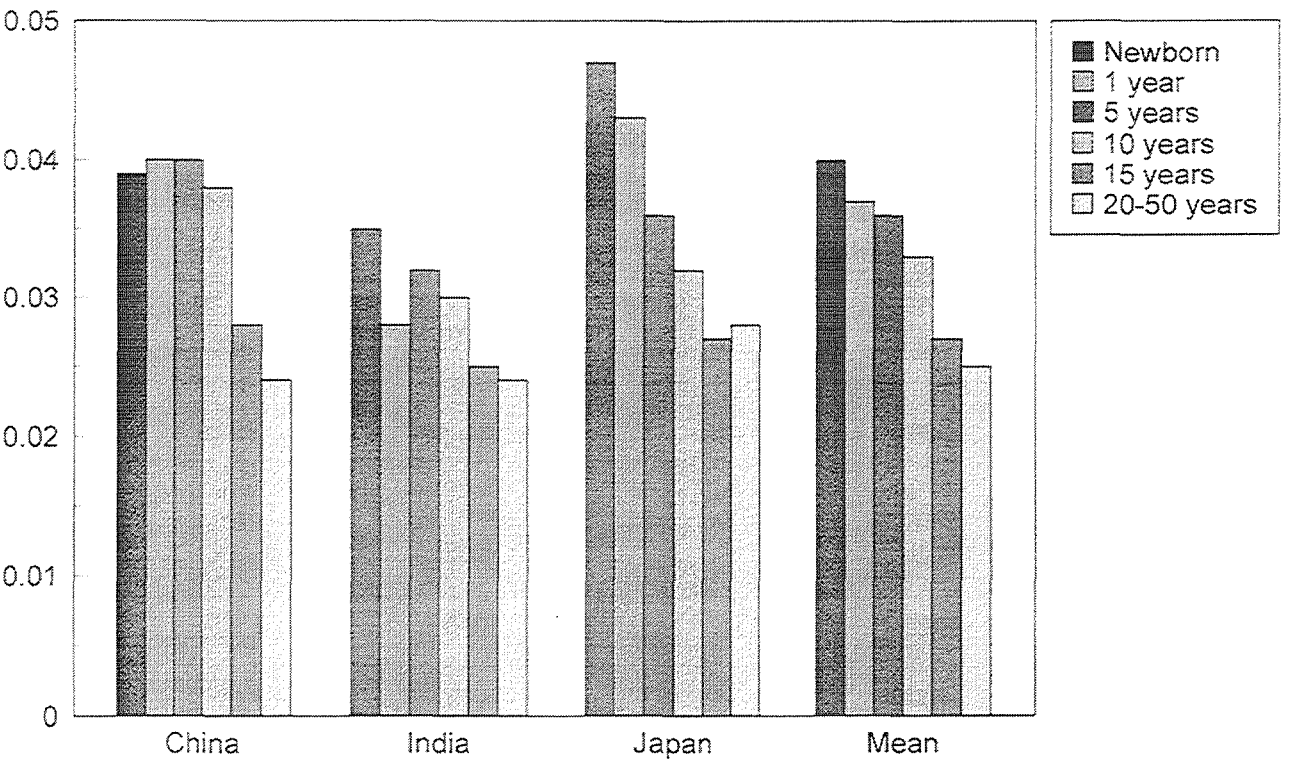


FIG. 16. Body mass fraction for liver — Female.

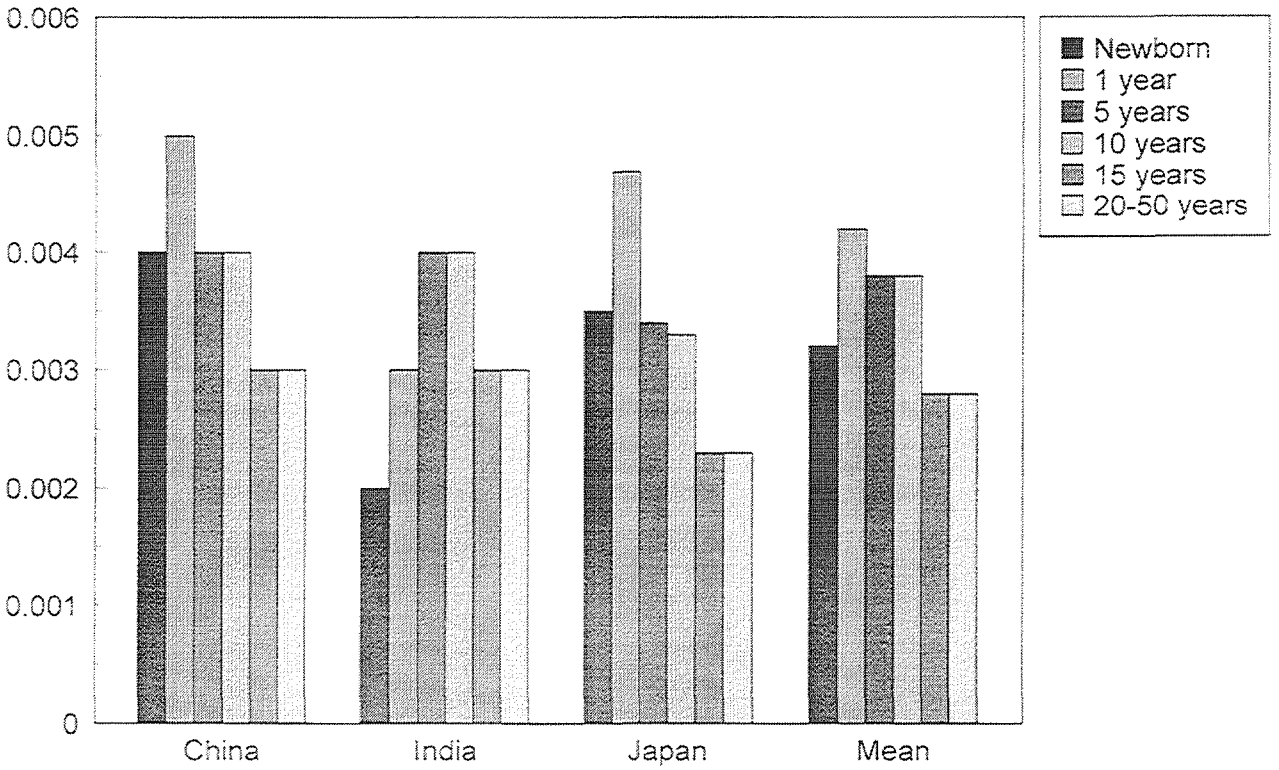


FIG. 17. Body mass fraction for spleen — Male.

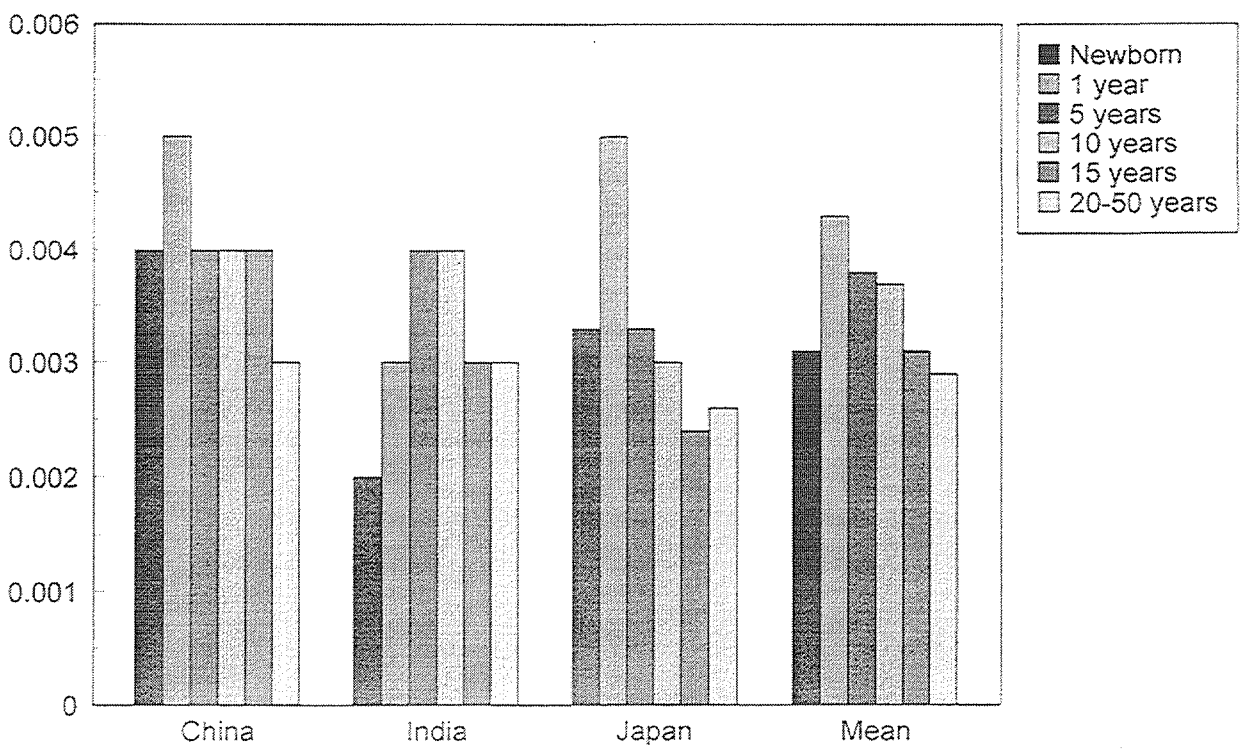


FIG. 18. Body mass fraction for liver — Female.

TABLE XVII FRACTIONAL ORGAN MASS - BRAIN, HEART, KIDNEY, LIVER AND LUNG

		Brain				Heart				Kidney				Liver				Lung			
SEX	AGE	China	India	Japan	Mean	China	India	Japan	Mean	China	India	Japan	Mean	China	India	Japan	Mean	China	India	Japan	Mean
Male	Newborn	0 131	0 1	0 13	0 120	0 007	0 006	0 0075	0 0068	0 009	0 007	0 0082	0 0081	0 038	0 034	0 045	0 039	0 021	0 022	0 024	0 022
	1y	0 114	0 095	0 120	0 110	0 007	0 004	0 0060	0 0057	0 009	0 007	0 0071	0 0077	0 041	0 030	0 044	0 038	0 021	0 015	0 020	0 019
	5y	0 078	0 069	0 085	0 077	0 006	0 005	0 0058	0 0056	0 007	0 007	0 0070	0 0070	0 037	0 033	0 038	0 036	0 022	0 018	0 019	0 020
	10y	0 053	0 050	0 053	0 052	0 005	0 006	0 0064	0 0058	0 007	0 006	0 0067	0 0066	0 034	0 035	0 034	0 034	0 021	0 020	0 019	0 020
	15y	0 030	0 030	0 029	0 030	0 005	0 006	0 0060	0 0057	0 005	0 005	0 0048	0 0049	0 025	0 024	0 027	0 025	0 016	0 017	0 018	0 017
	20-50y	0 027	0 024	0 026	0 026	0 005	0 005	0 0068	0 0056	0 005	0 004	0 0058	0 0049	0 023	0 022	0 029	0 025	0 017	0 016	0 021	0 018
Female	Newborn	0 138	0 1	0 130	0 123	0 007	0 006	0 0074	0 0068	0 009	0 007	0 0079	0 0080	0 039	0 035	0 047	0 040	0 020	0 022	0 024	0 022
	1y	0 112	0 086	0 110	0 103	0 006	0 0045	0 0054	0 0053	0 008	0 0065	0 0070	0 0072	0 040	0 028	0 043	0 037	0 022	0 013	0 019	0 018
	5y	0 074	0 072	0 079	0 075	0 006	0 005	0 0066	0 0059	0 007	0 0068	0 0066	0 0068	0 040	0 032	0 036	0 036	0 021	0 015	0 019	0 018
	10y	0 055	0 048	0 046	0 050	0 006	0 006	0 0060	0 0060	0 006	0 0064	0 0059	0 0061	0 038	0 030	0 032	0 033	0 018	0 018	0 017	0 018
	15y	0 036	0 027	0 029	0 031	0 005	0 006	0 0053	0 0054	0 006	0 0057	0 0051	0 0056	0 028	0 025	0 027	0 027	0 018	0 016	0 015	0 016
	20-50y	0 025	0 026	0 028	0 026	0 005	0 005	0 0066	0 0055	0 005	0 0048	0 0060	0 0053	0 024	0 024	0 028	0 025	0 016	0 015	0 019	0 017

TABLE XVIII. FRACTIONAL ORGAN MASS - PANCREAS, SPLEEN, TESTES AND THYROID

		Pancreas				Spleen				Testes			Thyroid			
SEX	AGE	China	India	Japan	Mean	China	India	Japan	Mean	India	Japan	Mean	China	India	Japan	Mean
Male	Newborn	0 002	0 001	0 0015	0 0015	0 0040	0 002	0 0035	0 0032	0 0007	0 00045	0 00058	0 0008	0 0005	0 00044	0 00058
	1y	0 002	0 002	0 0025	0 0022	0 0050	0 003	0 0047	0 0042	0 0004	0 00026	0 00033	0 0003	0 0004	0 00028	0 00033
	5y	0 002	0 002	0 0025	0 0022	0 0040	0 004	0 0034	0 0038	0 0004	0 00018	0 00029	0 0004	0 0003	0 00027	0 00032
	10y	0 003	0 002	0 0027	0 0026	0 0040	0 004	0 0033	0 0038	0 0003	0 00015	0 00023	0 0005	0 0003	0 00027	0 00036
	15y	0 002	0 002	0 0020	0 0020	0 0030	0 003	0 0023	0 0028	0 0006	0 00067	0 00064	0 0002	0 0003	0 00032	0 00027
	20-50y	0 002	0 002	0 0024	0 0021	0 0030	0 003	0 0023	0 0028	0 0007	0 00065	0 00068	0 0005	0 0004	0 00034	0 00041
Female	Newborn	0 002	0 001	0 0019	0 0016	0 0040	0 002	0 0033	0 0031				0 0008		0 00043	0 00062
	1y	0 002	0 002	0 0018	0 0019	0 0050	0 003	0 0050	0 0043				0 0003		0 00029	0 00030
	5y	0 003	0 002	0 0027	0 0026	0 0040	0 004	0 0033	0 0038				0 0004		0 00029	0 00035
	10y	0 002	0 002	0 0022	0 0021	0 0040	0 004	0 0030	0 0037				0 0005		0 00027	0 00039
	15y	0 002	0 002	0 0022	0 0021	0 0040	0 003	0 0024	0 0031				0 0003		0 00033	0 00032
	20-50y	0 002	0 002	0 0024	0 0021	0 0030	0 003	0 0026	0 0029				0 0004		0 00036	0 00038

TABLE XIX PATTERNS OF CHANGE IN FRACTIONAL ORGAN MASS WITH AGE IN YEARS

	Pattern of change with age	Organ
a	Maximum in newborn, and roughly linear decrease until adult	Brain Liver (slight increase in adult in Japanese) Kidney (slight increase in adult in Japanese)
b	Maximum in newborn, and some increase/decrease until adult	Heart Lung (some increase in adult) Thyroid (slight increase in adult)
c	Maximum in newborn, and "exponential" decrease until adult	Thymus (shoulder at 5-10y) Pituitary gland Adrenal gland
d	Decrease in 1-10y, and sharp increase to maximum > 15y	Testis
e	Maximum in 1y or 5y, and then decrease until adult	Spleen
f	Increase in 1y, maximum in 10y, and then some increase/decrease Increase in 1y, maximum in 5y, and then some increase/decrease	Pancreas (male) Pancreas (female)

TABLE XX MALE ADULT FRACTIONAL ORGAN MASSES

Organ	Estimated for other countries			Mean of CPR IND and JPN	Tanaka Model calculated	Reference Male calculated
	IDN	PHI	VIE			
Brain	0 025	0 025	0 026	0 026	0 025	0 020
Heart	0 0048	0 0060	0 00500	0 0056	0 0063	0 0047
Kidney	0 0039	0 0053	0 0057	0 0049	0 0053	0 0044
Liver	0 022	0 026	0 027	0 025	0 027	0 026
Lung	0 015	0 019	0 013	0 018	0 020	0 014
Pancreas	-	0 00230	0 00242	0 0021	0 0022	0 0014
Pituitary	-	-	0 00001	0 00001	0 00001	0 00001
Spleen	0 0021	0 0025	0 0032	0 028	0 0022	0 0026
Testis	0 00049	-	0 00072	0 00068	0 00060	0 00050
Thymus	-	-	0 00019	0 00056	0 00053	0 00029
Thyroid	0 00031	0 00039	0 00069	0 00041	0 00032	0 00029
Adrenal	0 00021	0 00030	-	0 00025	0 00023	0 00020

TABLE XXI FEMALE ADULT FRACTIONAL ORGAN MASSES

Organ	Estimated for other countries			Mean of CPR, IND and JPN	Tanaka Model calculated	Reference Female calculated
	IDN	PHI	VIE			
Brain	0 025	0 027	0 027	0 026	0 026	0 021
Heart	0 0044	0 0059	0 0049	0 0055	0 0064	0 0041
Kidney	0 0039	0 0060	0 0059	0 0053	0 0056	0 0047
Liver	0 023	0 028	0 028	0 025	0 027	0 024
Lung	0 015	0 018	0 013	0 017	0 018	0 0138
Pancreas	-	0 0021	0 0024	0 0021	0 0023	0 0015
Pituitary	-	-	0 00001	0 00001	0 00001	0 00001
Spleen	0 0021	0 0025	0 0030	0 0029	0 0025	0 0026
Thymus	-	-	0 00059	0 00054	0 00058	0 00034
Thyroid	0 00036	0 00061	0 00077	0 00038	0 00034	0 00029
Adrenal	0 00020	0 00051	-	0 00027	0 00026	0 00024

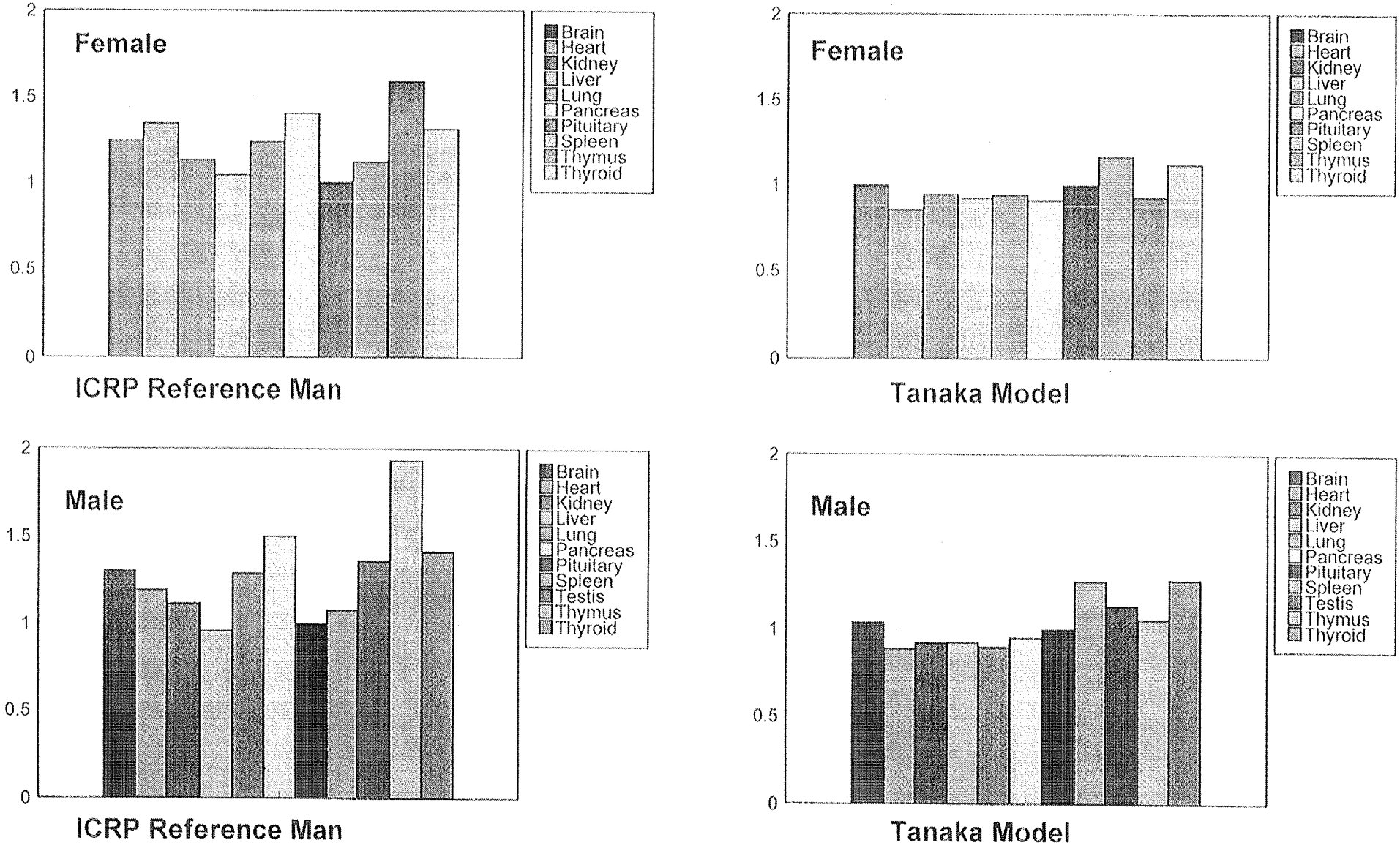


FIG. 19. Ratio of mean fractional organ masses to reference values.

When organ mass data are not available in a particular Asian population, it would be very useful to establish scaling algorithms so that the mass of an organ could be estimated from the body mass using the fractional organ mass data. There are, however, limitations in the use of the fractional masses of organs in attempting to use interpolation or extrapolation of organ masses, specially for an individual adult. In fact, in the Japanese data, correlation between organ mass and the body weight of individual subjects were shown not to be very high in the adult male and female of 20-49 years [16].

Summary

Data for twelve organs for the male and fourteen for the female of six age brackets, especially for 20-50 y, were obtained from one to seven participating countries. They may be regarded as the most comprehensive data for internal dosimetry in the Asian region at this time.

The total means and standard deviations were calculated to show average organ masses and their variations in the region studied in this CRP. The data were also compared with the ICRP Reference Man data and the Japanese Tanaka Model for Reference Asian adult male and female.

The results showed fairly equivalent brain and testes weights for Asian and European populations. Larger weights than those of the ICRP Reference Man were reported for organs such as pancreas and thymus, as well as the thyroid in some countries.

Information on a few additional organs (adrenals, prostate, uterus and salivary glands) were collected by one to four participants.

REFERENCES

[1] Report of Project Formulation Meeting: Co-ordinated Research Programme, Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, Mito City, Japan, 17-21 October 1988.

[2] International Commission on Radiological Protection: Report of the Task Group on Reference Man, ICRP Publication 23, Pergamon Press, Oxford, 1975.

[3] International Commission on Radiological Protection: Annual Limits on Intakes by Workers, ICRP Publication 30, Part 1, Annal. ICRP 2(3/4) (1979).

[4] International Atomic Energy Agency: Working Material, Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, Research Co-ordination Meeting, Bombay, 8-12 April 1991.

[5] Jixian Wang, and Rusong Chen, Study on the Setting of Reference Chinese Man, This Report, Vol. II, pp 19-54.

[6] H.S. Dang, D.D. Jaiswal, M. Parameswaran, S. Krishnamony, Studies of the Anatomical Physiological and Metabolic Characteristics of Indian Population for Setting Up a Reference Man, This Report, Vol. II, pp 55-86.

[7] National Atomic Energy Agency of Indonesia, Anthropological Characteristics, Internal Organs Measurements, and Food Consumption of Indonesian People, 1989-1993, This Report, Vol. II 87-107.

[8] G. Tanaka and H. Kawamura, 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, This Report, Vol. II, pp. 108-123.

[9] Yung Jin Kim, Gook Hyun Chung, Jong Soon Kim and Young Jin Chung, Establishment of Reference Man in Republic of Korea, This Report, Vol. II, pp. 124-136.

[10] Erlinda S. Natera, Grace D. Cuevas, Edwin M. Azanon, Marvie B. Palattao, Raquel T. Espiritu, Marilou C. Cobar, Lorna H. Palad, and Benjamin Torres, Compilation of Anatomical, Physiological and Dietary Characteristics for a Filipino Reference Man, This Report, Vol. II, pp. 152-172.

[11] Nguyen Manh Lien, Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Viet Namese Man, This Report, Vol. II, pp. 173-197.

[12] Tanaka, G.: Reference Japanese Vol. 1, National Institute of Radiogical Sciences, Chiba, Japan, Report NIRS-M-85 (1992).

[13] Tanaka, G.: Anatomical and Physical Characteristics for Asian Reference Man-A Proposal, National Institute of Radiogical Sciences, Chiba, Japan, Report NIRS-M-95 (1993).

[14] Dang, H. S., Private communication (1995).

[15] Nguyen Manh Lien, Private communication (1995).

[16] Tanaka, G. and Kawamura, H., Anatomical and Physiological Characteristics for Asian Reference Man - Male and Female of Different Ages: Tanaka Model, National Institute of Radiogical Sciences, Hitachinaka, Japan, Report NIRS-M-115 (1996).

2.3. PHYSIOLOGICAL PARAMETERS

E.S. NATERA
Health Physics Research Group,
Philippine Nuclear Research Institute,
Diliman, Quezon City, Philippines

Introduction

The physiological characteristics of man depend on the intake, metabolism and excretion of stable elements from food, water, and air. The physiological behavior of natural radionuclides and radionuclides from nuclear weapons testing and from the utilization of nuclear energy is believed to follow the pattern of stable elements. Hence information on the normal physiological processes occurring in the human body plays an important role in the assessment of the radiation dose received by man.

Two important physiological parameters needed for internal dose determination are the pulmonary function and the water balance. In the Coordinated Research Programme on the characterization of Asian population, five participants submitted data on these physiological characteristics - China, India, Japan, Philippines and Viet Nam. During the CRP, data on other pertinent characteristics such as physical and dietary were simultaneously being collected. Hence, the information on the physiological characteristics alone, coming from the five participants were not complete and are probably not sufficient to establish standard values for the Reference Asian Man. Nonetheless, the data collected is a valuable contribution to this research programme.

Pulmonary Function

The metabolic demands of the human tissues are dependent on the exchange of oxygen coming from the air and the release of carbon dioxide from the human body. This is called the respiratory physiology or simply exchange of gases. Several processes are involved in this mechanism with the lungs playing an important role.

The estimation of the quantity of radiation seeking entry to the human body by inhalation requires data on the pulmonary status of the individual. The uptake, retention and the elimination rate of radionuclides can be calculated by using the respiratory physiology data. Such information would include the lung volume and the respiratory capacity. Hence in this study, components of pulmonary function that include vital capacity total lung capacity, minute volume and the 8-hr working volume were presented in the final RCM of the CRP on Reference Asian Man. By definition, the vital capacity is the maximum volume of oxygen that can be expelled from the lungs by forceful effort after a maximal inspiration. The total lung capacity is the amount of oxygen contained in the lungs at the end of a maximal inspiration. The minute volume or respiratory volume is the amount of gas in the lungs after a respiratory cycle (breathing per minute). The 8-hr working volume is the amount of oxygen contained in the lungs within 8-hr working time.

The lung volumes were measured by the process of inhalation and exhalation using the bell shaped instrument called the spirometer. Other lung volume studies were conducted using the helium gas dilution method or the nitrogen washout method. Another instrument used for the measurement of the lung volumes is the body box also called plethysmograph. This is a large airtight box like a telephone booth in which the subject sits. The pressure inside the box

can be measured accurately. The subject is asked to make respiratory effort against a closed mouthpiece at a particular lung volume. As he compresses the gas in his lungs, the lung volume decreases slightly. As a result, the volume of air in the box increases very slightly and its pressure falls slightly. Boyle's law is then applied to the box gas. Knowing the change in pressure, the change in the volume of the box gas and hence the lung can be determined.

The results of the studies conducted by the five Asian countries on the pulmonary function tests are given in Table 1. Subjects taken for this study were non-smokers with normal chest radiograph and with no symptoms of lung, heart and chest wall diseases. Most of the subjects were hospital personnel and university students.

Other data presented were extracted from routine medical examination files of students and from executive check-ups. Results presented during the final meeting were the total lung capacity, vital capacity, and minute volume using the electronic spirometer, or the body box. The data were classified according to age, gender and the three levels of activity namely resting activity (RA), light activity (LA), and heavy activity (HA). Most of the data presented on these levels of activity were conducted by simulated experiments or were calculated from age specific basal metabolic rates and from the energy consumption or volume of energy consumed per kilo calorie. Hence, the results presented for the light and heavy levels of activity for the minute and 8-hr working lung volumes were approximate ventilatory equivalent like the data submitted by Japan.

Results of simulated experiments conducted for the light and heavy levels of activity were presented by the Philippines. The studies were done by performing a one minute exercise with the Wright's spirometer in the subject's mouth and using a foot stool for climbing up and down. The information gathered on this experiment was used for the values assigned for the light activity of the subject. The values for the heavy activity were gathered from the same experiments conducted but this time the exercise was extended for another minute. For the data on the resting activity, the actual results of the pulmonary function conducted in the sitting position were used. The pulmonary function results were calculated using standardized predictive equations for each lung function.

Observed values presented in Table 1 for the pulmonary function tests for the Reference Asian Man Studies showed lower results than the Caucasian data published in ICRP Report 23 for both male and female data (1). However the limitations of these data include variations in the procedures used in the experiments, the use of various kinds of testing equipment, the time frame in which these data were collected and the contribution of racial factors. In addition, countries like China and India did not submit data on the values for the lung volumes assigned for light and heavy activities. With these limitations, this study presents shows the first reference values on the pulmonary function status of an Asian that can initially provide information for the radiation protection group of the International Commission on Radiological Protection (ICRP).

Water Balance Studies

Water constitutes seventy-three percent (73%) of the lean body mass of a normal individual (2). The total body water is divided into several compartments namely extracellular and intracellular fluid (2). The body content of water is kept constant by the maintenance of a balance between intake and output. Water intake is normally derived from materials entering the body through the gastrointestinal tract, largely by drinking of fluid in response to the sensation of thirst. Water is lost through the lungs, skin, urine and faeces.

The Water Balance Studies of the Reference Asian Man Project were done by measuring the 24-hr liquid intake of healthy volunteer subjects and by again measuring the corresponding elimination in the urine, sweat, breath and faeces. The observed values taken from the five

TABLE I. RESULTS OF PULMONARY FUNCTION TESTS IN ADULTS

Country	N	Age	Sex	Total lung capacity	Vital capacity	Minute volume			8-hr working volume		
						RA	I A	HA	RA	LA	HA
China			M	5 76	4 08	6 63					
			F	4 35	2 95	5 64					
India	2,620	17-54	M	4 90	3 30	8 10					
	504		F	3 70	2 20	5 70					
Japan	192	20-25	M	5 67	4 23	5 10	10 20	87 00	2 448	4 896	41 762
	70		F	4 05	2 90	4 20	8 40	52 50	2 016	4 032	5 20
Philippines	25	20-45	M	5 00	3 50	14 86	22 60	49 01	7 133	10 848	23 52
	25		F	4 21	2 70	10 74	21 62	42 64	5 155	10 378	20 46
Viet Nam	357	20-50	M	4 43	3 63						
	284		F	3 28	2 73						

TABLE II RESULTS OF WATER BALANCE STUDIES IN ADULTS

COUNTRY	N	AGE	SEX	INTAKE Liter/Day	EXCRETION Liter/Day
China			M		
			F		
India	98	20-50	M	4 53	4 40
	20	20-50	F	3 60	
Japan	9	18-21	M	3 31	3 30
	6	19-22	F	2 70	2 70
Philippines	40	20-45	M	3 40	1 31
	116	20-45	F	2 96	1 27
Viet Nam	6	20-39	M	2 53	2 48
	6	20-39	F	2 14	2 09

Asian countries are summarized in Table 2. The values for liquid intake ranged from 2.14 to 4.53 liters per day. The excretion rates observed ranged from 1.27 to 4.40 liters per day. Majority of the data on the excretion were taken from elimination via the urine. Some measurements of elimination from the breath, faeces and sweat were also presented. Details of these studies are presented in the respective country reports.

REFERENCES

[1] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION: Report of the Task Group on Reference Man, ICRP Publication 23, Pergamon Press, Oxford, 1975.

[2] BROEBECK, J.R., BEST AND TAYLOR'S Physiological Basis of Medical Practice Tenth Edition. The Williams and Wilkins Company, Baltimore, USA, 1979.

2.4. DAILY DIETARY INTAKE

H.S. DANG
Low Level Counting Laboratory,
Bhabha Atomic Research Centre Hospital,
Mumbai, India

Introduction

The knowledge of the daily dietary intake pattern of a population group living in a region is important from the viewpoint of strengthening national and regional radiation protection programmes. Information is required on different dietary components such as principal nutrients (carbohydrates, proteins, energy), micro nutrients (including trace elemental intake) and intakes of different items of diet such as, cereals, pulses, vegetables, flesh foods, fruits, etc. These data are required in radiation protection in the event of an accidental or planned release of radioactivity (nuclear waste disposal) during different nuclear operations when ingestion as well as inhalation could become a source of radioactivity exposure. In such circumstances, there is a need to identify the potential radioactivity carriers, in order to make relevant decisions for controlling radioactive exposure to humans through food.

The dietary data on the intake of important trace elements such as Cs, I, H, Th, U, etc. along with their tissue concentrations could provide valuable information on relevant metabolic parameters such as the biological half-life ($t_{b1/2}$), gut absorption factor (f_1) and tissue retention factors (f_2) which are important in internal dose assessment.

As part of study on "Reference Asian Man" to strengthen radiation protection, the data on the dietary consumption patterns of the Asian region were collected. Eight provided dietary data - Bangladesh, China, India, Indonesia, Japan, Pakistan, Philippines, and Viet Nam. Whereas the dietary data from Bangladesh, Indonesia, Pakistan and Viet Nam are preliminary in nature, the dietary information from China, India, Japan and Philippines, on the other hand, is quite substantial. The population of the countries from which sufficient dietary data are available represents more than 2/3 of the population of the Asian region. The details of the individual data available on dietary parameters from different Asian countries are listed below.

Bangladesh

The daily dietary consumption of different kinds of food stuff such as cereals, pulses, vegetables, fruits, flesh food and milk, etc. have been reported for different age groups of the Bangladesh population. The age groups covered are 0, 1, 5, 10, 15y and adult. Among the adult population, two different age groups, 20-50y and above 50y, are included in the study. Until 10 years of age, only the combined population has been considered, whereas for 15y and adult age groups, both male and female populations are included in the dietary study. The daily dietary elemental intake is also estimated for different age groups through the determination of the concentration of trace elements in 10 different food items of daily consumption.

The daily dietary consumption of individual food items such as cereals, pulses (legumes), potatoes (starch), sugars, fat and oil, fruits, flesh foods, milk and water for different age groups are presented in the country report. As to be expected, for the newborns, the only intake is about 400 ml of milk and 15 g of sugar. Milk consumption declines steadily with increasing age, whereas the consumption of cereals, pulses, vegetables and flesh foods increases with increasing age. Except for the newborns, the main source of energy (Calories) for the Bangladesh population is the cereals diet.

The daily intake of seven elements (K, Ca, Mn, Fe, Cu, Zn and Sr) is estimated through the determination of their concentrations in different food items including cereal, pulses, vegetables, milk, flesh food, etc. The highest concentrations for most of the elements is in pulses and the minimum is in drinking water. The daily intake of all 7 elements shows a steady increase with age. The intake by the female population is consistently lower in all three age groups for which data are available.

China

A substantial amount of data are reported from China on different dietary parameters including: (1) the daily dietary consumption of different kinds of food stuff by Chinese population groups from different regions and belonging to different age groups; (2) intake of principal nutrients such as carbohydrate, protein, fat, alcohol, etc. along with the energy provided by these sources; (3) daily elemental intake by the adult Chinese population; (4) data on the daily dietary intake of 17 radionuclides. A comparison of the daily intake of important dietary components in two different periods (1982 and 1990) is also reported for Chinese population. Most of the reported data are for adults, however, some data from 1982 on the consumption of different foods are also reported for three groups of younger Chinese population.

A notable feature of the daily consumption of different food stuffs is the substantial consumption of vegetables and fruits and extremely low consumption of milk by the Chinese adults. It is clear that, in place of the consumption of potatoes as the starch source, the Chinese consume large quantities of yams. As compared to the consumption of flesh foods by other Asian countries like India, Bangladesh and Pakistan, the consumption of flesh foods by the Chinese population is much higher. The main source of energy for the Chinese is also the cereal diet. Along with rice the Chinese population consumes an equal amount of wheat.

The daily dietary intake of major (C, H, O, N, S) and other elements has been reported. A comparison of the dietary intake of 30 elements as estimated in various surveys conducted during the years 1982, 1985, 1986 and 1990 is also presented. When the dietary elemental intake by the Chinese (1990 survey) population is compared with the ICRP data, a significant difference in the intake of most of the elements is observed.

The intake of 17 radionuclides by Chinese adults and the percentage contribution of different food items and water to the intake of these radionuclides by the Chinese population is also presented.

In summary, cereals and vegetables were the main food and sources of energy for the Chinese. The daily intake of radionuclides is reported only for the Chinese population among the Asian countries.

India

The daily intake of principal nutrients for the rural and urban Indian population and weighted mean national consumption values have been determined. The data are reported in consumption unit (CU), which is the coefficient for computing the calorie requirement for different groups of population indulging in sedentary, moderate or heavy work. CU value for sedentary male workers is taken as 1.0 and that for moderate and heavy workers is 1.2 and 1.6, respectively.

The daily intakes of various food components such as cereals, pulses, vegetables, fruits, flesh foods and milk, etc. are reported for rural and populations urban as well as the national average consumption.

The per capita protein and energy intake for the age groups 1, 2, 5 and 12 y are reported for the combined (male and female) population groups whereas for the population in 13-16y, 16-18 y and adult age groups, the data are reported for both male and female subjects. The average consumption of various food items by the Indian population in the age groups 1, 2, 5, 12 and 15 y shows that the consumption of various food items increases with age. The energy supply received by the Indian population in different age groups from different food items indicates that the major supply of energy (85-92%) is received from the consumption of cereals, pulses and milk.

The average intake of 14 minor and trace elements by the Indian population in the age groups 2, 5, 12, 15 and adult was estimated by the elemental analysis of the individual food items using the technique of neutron activation analysis (NAA) and atomic absorption spectrophotometry (AAS). The elemental concentrations of the individual food items along with the average quantity of food items consumed by the different age groups of the population were used to arrive at the daily elemental intake. The elemental intakes increase with age. However, intakes at 15 y are quite similar to intakes by the adult population.

The intakes of a few more elements were also determined through the analysis of the duplicate diet. The intakes of these elements, namely, Th, U and I, were obtained only for the adult population.

Indonesia

From Indonesia, very limited data, based on an equally smaller size survey, has been reported on the dietary intakes of the Indonesian population for the age groups 1-3, 4-6, 7-9, 10-12, 20-39, 40-59 y and >60 y. It is clear that the consumption patterns are quite different in the three regions reported in the study. The elemental concentrations for eight elements in the common food stuffs consumed in Indonesia are also presented. Since the data available from Indonesia is limited and based on a smaller survey size, it could well be termed as preliminary in nature and could be only of information value.

Japan

The daily dietary intake of principal nutrients such as energy, protein, fat and the micro nutrients (trace elements) along with the daily consumption pattern of different food items is reported from Japan. The daily dietary intake of 15 minor and trace elements is also reported for the adult Japanese population. The average intake of different food items consumed by the Japanese population, on a per capita basis between the years 1975 and 1985, is presented. It is interesting to note that the average consumption of fruits and vegetables is quite high and so is the case with the consumption of flesh foods.

The daily average intakes of some of the principal nutrients per capita for the 12y period between 1973 to 1984 are reported for carbohydrate, protein (both animal and total), fat and oil, energy and a few vitamins and mineral elements. The breakdown of the contributions of different food items to the total energy supply to the Japanese population shows that about 50% of the total energy is derived from cereals and a significant amount of energy is also contributed by the flesh foods and sugar.

The intake of 15 elements for the adult Japanese population has been measured. The highest daily dietary intake is of sodium (Na), an essential element for humans and the lowest for yttrium (Y), which is non-essential and therefore non-consequential to the human system. A comparison between the Japanese and ICRP data clearly shows the elemental intake for Japanese is in general lower than that for ICRP Reference Man.

Detailed information is available on most of the dietary aspects of the Japanese population, including the daily intake of food items, the intake of principal nutrients, the main sources of energy available from diet and also the average elemental intakes.

Pakistan

Data are reported from the Pakistan population on the different kinds of food items consumed daily by the Pakistan population and the percentage of calories provided by the consumption of each of these food items. The average daily intake of the different food items by the rural and urban national average along with the typical food intake in two cosmopolitan big cities of Pakistan are also reported. The calories provided by the consumption of individual food items in different regions of Pakistan are reported along with the other data.

99% of the adult population consumes cereals whereas only 61% of the children in 2-5y age group consume cereals. Only about 40% of the population in different age groups consumes milk. Similar data on consumption of pulses, meats, eggs, fish, oil, vegetables, etc. are presented.

The average regional consumption of different food items by the adult Pakistani population has been measured. The 150 g of the daily consumption of tea seems to be high. The consumption of cereals by the inhabitants of the bigger cities is much lower than that of the rural population. The maximum calories to the daily energy intake are provided by cereals followed by those through oil, sugar and milk.

The calorie intake in Pakistan by the male, female and other age groups of the Pakistan population indicates that the actual intake is marginally lower than the recommended values, with the exception of adult females and 1-2y age group, where the calorie intake is commensurate with the requirements.

Philippines

The dietary data based on a small but systematic survey is reported on the Filipino population from Philippines. The results are reported for the daily dietary intake of food items and the daily elemental intake for both the male and female populations of Philippines. Daily dietary intakes of food items such as cereals, pulses, nuts, potatoes, fat and oil, fruits, etc. are reported both for the male and female population. A noteworthy feature of the report is a very low daily energy consumption of 1614 Kcal by the Filipino population.

The daily dietary intake of 10 elements by the adult male and female Filipino population has been measured. The average elemental intake of the female population is in general lower than that for the male population. An interesting feature of the data is the very low consumption of Cu and I by the Filipino population.

Viet Nam

The daily intake of different food items by the adult Viet Namese population living in different regions of urban and rural areas of Viet Nam, along with the country averages, are reported from Viet Nam. The average contribution of energy provided by different food items to the daily calorie intake are also reported.

The average food consumption data for presented Viet Nam (1990-1991) includes the intake of rice, potatoes, sugar, oils, vegetables, fruits, flesh foods, etc. The consumption of oil seeds by the Viet Namese is quite low. The staple food of the population is rice.

Measurement of the average daily intake of principal nutrients such as energy, protein, fat, carbohydrate, minerals along with the percentage contributed by the individual food

material to the daily energy intake shows that the main contribution of energy, as usual, comes from glucids (carbohydrates), followed by that from protein.

GENERAL DIETARY INTAKE PATTERNS

Intake of principal nutrients

The principal nutrients include carbohydrates, protein, fat and total energy. The intake pattern of principal nutrients reported from China, India, Japan, Philippines and Viet Nam is summarized in Table 1. The intake of carbohydrates ranges between 320-405 g, whereas that by protein is in the range of 54.5-87 $g.d^{-1}$. There is large variation in the intakes of fat, being lowest at 15.8 g for Viet Nam and highest for Japan 56.2 g. The variation is by a factor of about 3.5. The energy intake varies from 1614 to 2739 kcal, whereas that of Ca and Fe is 400-582 mg and 9.8-22.7 g, respectively. In comparison to the ICRP data, the intake of carbohydrates and iron is comparable, whereas the intake of the other principal nutrients in the reporting Asian countries is lower. The comparison shown is for the male population only. The comparison for the female population groups with ICRP data shows similar patterns as in the case of the male population.

Intake of dietary food items

The data on intake of daily dietary food items such as cereals, pulses, milk, oils, fruits, vegetables, etc. are available from Bangladesh, India, China, Japan, Philippines, Pakistan and Viet Nam. For a few of these countries, the data are available for adult as well as younger groups of the population, whereas in other countries, the data are available only for the adult population. A comparison is shown in Table 2.

The comparison of the dietary patterns of the different Asian countries clearly shows that in spite of the close geographical proximity of the Asian countries, there are significant differences in the dietary patterns of the Asian population. Although the staple diet of the Asian population is rice, the population of countries like India, China and Pakistan consume significant amounts of wheat. There are very large variations in the consumption of flesh foods (range 12-172 g), mile (0.4-161 ml) and fruits (20-164.9 g) in different Asian countries. Again, in China, yam is consumed as an alternate to potatoes. The consumption of most of the food items is lower in Asian countries when compared with the intake for USA diets which are more representative of ICRP Reference Man. The consumption of milk is notably lower among different population groups in Asia.

Daily elemental intake

India, China, Japan, Bangladesh, and Philippines have provided data on the daily dietary intakes of a number of elements. A comparison of the estimates of dietary elemental intakes of elements by the adult populations in Table 3 shows significant variations in the elemental intakes by the population groups in different Asian countries. The variation at times is by a factor of more than two.

TABLE I. INTAKE OF PRINCIPAL NUTRIENTS BY ASIAN POPULATIONS

Country	Daily dietary intake					
	Carbohydrate (g)	Protein (g)	Fat (g)	Energy[a] (KCal)	Ca (g)	Fe (mg)
China[b]	366.	64.0	51.2	2203.	0.58	22.7
India[b]	405.	54.5	29.0	2040.	0.40	19.0
Japan[c]	320.	87.0	56.2	2739.	0.55	11.3
Philippines[b]	-	-	-	1614.	0.50	11.6
Viet Nam[c]	376.	59.7	15.8	1932.	0.55	9.8
Range	320. - 405.	54.5 - 87.7	15.8 - 56.2	1614. - 2739.	0.40 - 0.58	9.8 - 22.7
ICRP	390.	95.	120.	3000.	1.1	16.0

a. Indirectly determined based on assumed calorie content of food item intake

b. Daily intake values - per adult

c. Daily intake values - per Caput

TABLE II DAILY DIETARY INTAKE OF SELECTED FOOD ITEMS

Food Item (g)	Bangladesh	China	India	Indonesia	Japan	Pakistan	Philippines	Viet Nam	Range	ICRP
Cereal	520	461	469	171	322	502	391	462	50 2 - 520	207
Pulses	120	39 5	35	114	69	43	91	-	35 - 114	-
Flesh	54	72	12	115	161	39	172	85	12 - 172	228
Eggs	5	11	-	46	41	7	31	2	2 - 46	47
Vegetables										
Total	150	324	65	75	260	91	143	183	65 - 324	202
Green	-	-	20	-	59	10	59	-	-	-
Other	-	-	-	-	-	-	105	-	-	-
Fruits	20	101	20	156	165	8	113	2 6	2 6 - 165	184
Milk	20	11	100	147	114	161	9	-	9 - 147	508
Oil/Fat	6	31	15	29	18	33	22	25	6 - 33	49
Sugars	10	3	29	36	13	39	64	1	1 - 64	
Basis for daily intake values	Per adult	Per adult	Per adult	Unspecified	Per Caput	Unspecified	Unspecified	Per Caput		
Sampling basis for values	National Diet sampling	National Food basket	National Food basket	Unspecified	National Diet sampling	Unspecified	Unspecified	National Food basket		

TABLE III. DAILY DIETARY ELEMENTAL INTAKE OF ASIAN POPULATIONS

Country	Daily Elemental Intake									
	K (g)	Na (g)	Ca (g)	Mg (g)	Fe (mg)	Zn (mg)	Cu (mg)	Mn (mg)	Cr (mg)	Sr (mg)
Bangladesh[a]	1.46	-	0.45	-	12.5	13.7	2.2	8.6	-	1.3
China[a]	1.12	3.75	0.58	0.28	22.7	9.8	4.8	5.9	0.48	1.5
India[a]	1.80	5.90	0.40	0.50	19.0	10.3	2.2	5.1	0.13	-
Japan[c]	2.00	4.70	0.58	0.21	12.0	7.7	1.3	4.0	0.18	2.3
Philippines[b]	0.82	1.57	0.50	0.31	11.6	10.9	0.6	3.7	-	-
Range	0.82 - 2.20	1.57- 5.90	0.40 - 0.58	0.21 - 0.50	11.6 - 22.7	7.7 - 13.7	0.6 - 4.8	3.7 - 8.6	0.13 - 0.48	1.3 - 2.3
ICRP	3.3	4.4	1.1	0.34	16.0	13.0	3.5	3.7	0.15	1.9

a. Daily intake values - per adult

b. Daily intake values - method unspecified

c. Daily intake values - per Caput

SUMMARY AND CONCLUSIONS

1. The dietary intake of principal nutrients such as carbohydrates, fat, protein, energy, along with the data on the daily intakes of different food items and the elemental intake, is available from Bangladesh, China, India, Indonesia, Japan, Philippines, Pakistan and Viet Nam.

2. Substantial dietary data are reported from China, Japan, India and Philippines. The limited data available from Bangladesh, Pakistan, Indonesia and Viet Nam provide useful information on the possible variations in the dietary intakes of food items among the Asian population belonging to different countries.

3. The dietary intake pattern of different Asian countries is quite different in certain respects in spite of the close geographical proximity of these countries. A typical example is of very low milk intake in China, Philippines and Viet Nam. On the other hand, the daily intake of flesh foods by the Indian population is very small.

4. The daily elemental intake by the population is different countries varies by a factor of more than two. In general, the elemental intake of the Asian population is lower than ICRP data. But for a few elements such as Fe, Sr, etc. the intake is comparable to the ICRP elemental intake data.

3. THE TANAKA MODEL[2]

Reference Asian Man
Male and female
Ages: newborn, 1 year, 5 years, 10 years, 15 years and adult

G. TANAKA
Asian Center for Reference Man Studies,
Isozaki, Nakaminato Ibaraki, Japan

Introduction

The data presented here includes male and female models for Asian populations in the age groups: Newborn, 1 year, 5 years, 10 years, 15 years and adult. The model for adult male was presented at the 3rd Research Coordination Meeting held in Tianjin, October 1993. At that time, the CRP participants requested Dr. Tanaka to continue development of a female model. The adult female model was developed together with models for five younger age groups. It is intended to provide useful data for radiation protection, and has been submitted to ICRP for use in developing revised models for internal dosimetry.

The model is based on normal organ masses as well as physical measurements obtained primarily from Chinese, Indian and Japanese populations. These are believed to be the most extensive data sets available. The data presented here also takes into account the variations found in the data reported by other CRP participants (1-5). It should be stressed that the model is, at the same time, based on the approach used by the ICRP Reference Man Task Group in development of their Reference Man.

As noted above, the adult male model was presented at the RCM Meeting in Tianjin and approved by the participants as "Tanaka Model" that would be convenient for use in internal dosimetry studies for subjects from Asian populations (6). It is also the essential part of a publication which is a revised edition of the previous work (7).

Contents

---

[2] First presented at the Project Formulation Meeting for the IAEA-RCA Reference Asian Man CRP (Phase2): Ingestion and Organ Composition of Trace Elements of Importance in Radiological Protection, Hitachinaka City, 27 February - 4 March, 1995.

Table I Physical properties, contents of blood, water, mineral, lipid and Protein of all organs and tissues for Asian Reference Man male(RAMM) and female(RAMF):0 year (3 months) [NIRS-M-85,95,115]

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
^1 Total body	6000	6000	640	640	5322	5321 6	4300	4300	200	200	600	600	700	700	1 08	1 08
1a Total soft tissue	5400	5400			5400	5400	3600	3600	37	37	1000	1000	810	810		
1b Total hard tissue	600	600			600	600										
2 Adipose tissue	560	560	15	15	544	544	140	150	1 9	1 5	360	360	49	47	0 94	0 94
3 Subcutaneous (hypodermis)*	320	320	7 9	7 9	312 *	312	80	80	1 1	0 68	210	210	27	17	0 99	0 99
4 Other separable*	200	200	6 3	6 3	193 *	193	52	52	0 7	0 7	130	130	18	27	0 94	0 94
5 Interstitial	40	40			40	40	13	13	0 16	0 1	24	24	4	2 5	0 94	0 94
6 Yellow marrow (skeleton)																
^7 Adrenals (2)*	4 3	4	0 3	0 3	4 0 *	3 7	3 1	2 9	d	d	0 5	0 5	0 4	0 3	1 04	1 04
8 Aorta*	13	13	*		13 *	13	9 1	9 1	0 19	0 19	0 16	0 16	3 5	3 5		
9 Contents*	24	24	23	23	*		20	20	0 24	0 24	0 13	0 13	4 4	4 4	1 08	1 08
^10 Blood	680	680	640	640			550	550	6 5	6 6	4 5	4 8	120	120	1 08	1 08
11 Plasma	380	380					350	350	3 5	3 6	2 5	2 8	25	25	1 05	1 05
12 Erythrocytes	300	300					200	200	3	3	2	2	98	98	1 11	1 11
13 Blood vessels*	26	26	*		26 *	26	20	20	0 16	0 16			6 1	6 1		
14 Contents (except aorta and pulmo	320	320	300	300	*		260	260	3 1	3 1	2 1	2 2	58	58	1 08	1 08
^15 Body fat	600	600			600	600					600	600			0 94	0 94
16 Essential	80	80			80	80					80	80			0 94	0 94
17 Nonessential	520	520			520	520					520	520			0 94	0 94
^18 Body water	4300	4300			4300	4300	4300	4300							1 02	1 02
19 Extracellular	1800	1800			1800	1800	1800	1800							1 02	1 02
20 Intracellular	2500	2500			2500	2500	2500	2500							1 02	1 02
21 Cartilage (skeleton)	130	130			130	130	100	100	5 3	5 3	1 6	1 6	20	20	1 12	1 12
22 Connective tissue	410	410			410	410	260	260	17	17	4 1	4 1	150	150	1 22	1 22
23 Tendons and fascia	170	170			170	170	110	110	6 9	6 9	1 7	1 7	64	64	1 22	1 22
24 Periarticular tissue	180	180			180	180	110	110	7 5	7 5	1 8	1 8	68	68	1 22	1 22
25 Other connective tissue	60	60			60	60	39	39	2 6	2 6	0 6	0 6	21	21	1 22	1 22
26 Separable connective tissue*	180	180	*		180 *	180	120	120	8 3	8 3	2 3	2 3	69	69	1 22	1 22
^27 Central nervous system*	660	480	11	11	648 *	468	510	380	9 7	7 1	71	51	51	38		
^28 Brain	650	470	13	13	637	457	500	370	9 6	6 9	70	50	50	37	1 05	1 05
29 Cerebrum	570	390			570	390	440	300	8 3	5 7	62	43	44	30		
30 Cerebellum	70	70			70	70	57	57	1 1	1 1	6 2	6 2	5 8	5 8		
31 Brain stem	10	10			10	10	7 7	7 7	0 15	0 15	1 1	1 1	0 8	0 8	1 06	1 06
32 Spinal cord	12	12			12	12	9 6	9 6	0 16	0 16	1 2	1 2	1	1	1 05	1 05
33 Contents (cerebrospinal fluid)*	16	16	*		16 *	16	16	16	0 1	0 1	*		0 0044	0 0044	1 03	1 03
^34 Eyes (2)*	6 7	3 9	*		6 7 *	3 9					*		*		1 05	1 05
^35 Lenses (2)	0 18	0 11			0 18	0 11	0 068	0 041	0 0004	0 0002	0 002	0 0012	0 035	0 021	1 12	1 12

Table I (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
36 Gall bladder*	1	1	*		1 *	1	0 99	0 99	0 0075	0 0075	*		*			
37 Contents (bile)*	7	7	*		7 *	7	6 7	6 7	0 07	0 07	0 13	0 13	0 034	0 034	1 05	1 05
38 GI tract*	160	160	*		160 *	160	120	120	1 3	1 3	9 5	9 5	20	20	1 06	1 06
39 Contents (food plus digestive flui	140	140	*		140 *	140	130	130	*		*		*			
40 Esophagus	7	7			7	7	5 3	5 3	0 063	0 063					1 06	1 06
41 Stomach	23	23	0 72	0 72	22	22	16	16	0 18	0 18	1 4	1 4	3 1	3 1	1 07	1 07
42 Contents	40	40			40	40										
43 Intestine	130	130			130	130	100	100	1	1	8 1	8 1	17	17	1 06	1 06
44 Contents	100	100			100	100										
45 Small intestine	83	83			83	83	65	65	0 65	0 65	5 2	5 2	11	11	1 06	1 06
46 Contents	50	50			50	50										
47 Duodenum	8	8			8	8	6 2	6 2	0 064	0 064	0 5	0 5	1	1	1 07	1 07
48 Jejunum	37	37			37	37	29	29	0 28	0 28	2 3	2 3	4 7	4 7	1 06	1 06
49 Ileum	38	38			38	38	30	30	0 3	0 3	2 4	2 4	4 9	4 9	1 06	1 06
50 Large intestine	47	47			47	47	37	37	0 38	0 38	3	3	5 2	5 2	1 06	1 06
51 Contents	50	50			50	50										
52 Upper large intestine	26	26			26	26	21	21	0 21	0 21	1 6	1 6	3 5	3 5	1 06	1 06
53 Contents	30	30			30	30										
54 Ascending colon and cecum	11	11			11	11	8 7	8 7	0 088	0 088	0 69	0 69	1 5	1 5	1 06	1 06
55 Transverse colon	15	15			15	15	12	12	0 12	0 12	0 93	0 93	2	2	1 06	1 06
56 Lower large intestine	21	21			21	21	17	17	0 17	0 17	1 4	1 4	1 8	1 8	1 06	1 06
57 Contents	20	20			20	20										
58 Descending colon	11	11			11	11	8 7	8 7	0 088	0 088	0 74	0 74	0 47	0 47	1 06	1 06
59 Sigmoid colon	7	7			7	7	5 6	5 6	0 056	0 056	0 43	0 43	0 91	0 91	1 06	1 06
60 Rectum	3	3			3	3	2 4	2 4	0 024	0 024	0 18	0 18	0 39	0 39	1 06	1 06
61 Hair*	0 2	0 2	*		0 2 *	0 2	0 017	0 017	0 001	0 001	0 0048	0 0048	0 18	0 18	1 32	1 32
^62 Heart*	37	33	8 8	8 8	28 *	24	22	19	0 1	0 1	3 5	3 4	2 6	1 9	1 05	1 05
63 Contents (av)*	57	57	54	54	*		46	46	0 57	0 57	0 36	0 36	10	10	1 08	1 08
^64 Kidneys (2)*	42	37	6 2	6 2	35 *	30	28	25	0 1	0 1	4 3	4 3	3 2	2 5	1 07	1 07
65 Larynx*	4	4	*		4 *	4	2 7	2 7	0 12	0 12	*		*		1 10	1 10
^66 Liver*	240	220	26	26	212 *	192	160	150	1 1	1	26	26	19	15		
^67 Lung*	140	140	79	79	56 *	56	110	110	1 4	1 4	1 3	1 3	26	26	1 07 deflated 0 26 inflated	1 07 0 26
68 Parenchyma (includes bronchial tree plus capillary blood)	60	60	11	11	48	48	46	46	0 66	0 66	0 74	0 74	11	11	1 02	1 02
^69 Blood (arterial and venous)	80	80	75	75			64	64	0 77	0 78	0 53	0 56	15	15	1 08	1 08
70 Bronchial tree	4	4			4	4										

Table I (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
71 Lymphocytes	190	190			190	190										
72 Lymphatic tissue	85	85			85	85										
73 Lymph nodes (dissectible)*	31	31	0 42	0 42	30 6 *	30 6	*		*		*		*			
74 Miscellaneous*	330	510	*		330 *	510	130	160	*		*		*			
75 Solid soft tissue	30	60			30	60										
76 Fluid (synovial, pleural, etc)	300	450			300	450	22	22								
^77 Muscle (skeletal)*	2000	2000	34	34	1964 *	1964	1600	1600	24	24	37	37	340	340	1 06	1 06
78 Nails (20)*	0 43	0 43	*		0 43 *	0 43	0 029	0 029	*		*		*		1 32	1 32
79 Pancreas*	11	9 8	1 3	1 3	9 6 *	8 4	7 7	6 8	0 1	0 1	1 2	1 1	0 9	0 7	1 07	1 07
80 Parathyroid (4)*	0 05	0 05	*		0 05 *	0 05	*		*		*		*		1 07	1 07
81 Pineal*	0 08	0 05	*		0 08 *	0 05	*		*		*		*		1 09	1 09
^82 Pituitary*	0 19	0 21	0 02	0 02	0 17 *	0 19	0 13	0 15	0 0033	0 0037	0 02	0 02	0 01	0 01		
83 Prostate*	1 *		*		1 *		0 72 *		0 015 *		0 012 *		0 13 *		1 07	1 07
83a Contents*	*		*		*		*		*		*		*			
84 Salivary glands (6)*	13	13	0 89	0 89	12 *	12	9 1	9 1	*		*		*		1 07	1 07
85 Parotid (2)	8	8	0 68	0 68	7 3	7 3									1 07	1 07
86 Submaxillary (2)	3	3	0 26	0 26	2 7	2 7									1 07	1 07
87 Sublingual (2)	2	2	0 13	0 13	1 9	1 9									1 07	1 07
^88 Skeleton*	600	600	20	20	579 *	579	240	220	220	210	130	120	150	140	1 43	1 43
^89 Bone	300	300	11	11	288	288	55	55	160	160	3	3	82	82	2 24	2 24
90 Cortical	240	240			240	240									1 88	1 88
91 Trabecular	60	60			60	60									1 10	1 10
92 Red marrow	110	110	5	5	105	105	44	44	0 65	0 65	44	44	22	22	1 05	1 05
93 Yellow marrow																
94 Cartilage	110	110			110	110	100	100	5 3	5 3	1 6	1 6	20	20	1 12	1 12
95 Periarticular tissue (skeletal)	80	80			80	80	64	64	4 1	4 1	1 3	1 3	16	16	1 12	1 12
96 Skin*	320	320	6 7	6 7	313 *	313	210	210	2 4	2 4	27	27	98	98	1 12	1 12
97 Epidermis	20	20			20	20									1 17	1 17
98 Dermis	300	300			300	300									1 14	1 14
^99 Hypodermis (see adipose tissue)	320	320			320	320									0 99	0 99
100 Spleen*	20	18	9 6	9 6	10 *	8	8	7 1	0 1	0 1	1 2	1 2	1	0 7	1 08	1 08
101 Teeth (32)*	20	12	*		20 *	12	0 71	0 47	4 5	2 7	*		0 15	0 14	2 14	2 14
102 Enamel	4	3			4	3	0 028	0 021	0 96	0 72			0 012	0 009	d	d
103 Dentin	16	9			16	9	0 54	0 31	3 5	2			0 022	0 012	d	d
104 Pulp	0 2	0 2			0 2	0 2	0 14	0 14	0 02	0 02	0 002	0 002	0 12	0 12	d	d
105 Testes (2)*	2 2 *		0 2 *		2 *		1 6 *		0 028 *		0 2 *		0 2 *		1 06	1 06

Table I (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
^106 Thymus*	25	26	5 5	5 5	19 *	20	15	16	0 1	0 1	2 3	2 6	1 9	1 7	1 05	1 05
^107 Thyroid*	1 8	1 8	0 2	0 2	1 6 *	1 6	1 2	1 2	*		0 2	0 2	0 1	0 1	1 07	1 07
108 Tongue*	30	18	*		30 *	18	6 7	4	0 1	0 063	1 6	0 96	1 6	0 96		
109 Tonsils (2 palatine)*	*		*		*		*		*		*		*			
110 Trachea*	1	1	*		1 *	1	0 56	0 56	0 016	0 016	*		*		1 10	1 10
111 Ureters (2)*	2	2	*		2 *	2	1 4	1 4	*		*		*			
112 Urethra*	1	1	*		1 *	1	0 76	0 76	*		*		*			
113 Urinary bladder*	5	5	*		5 *	5	3 9	3 9	0 048	0 048	*		*			
114 Contents (urine)*	14	14	*		14 *	14	14	14	0 16	0 16	*		0 91	0 91	1 04	1 04
^115 Breast*	1 3	1 3	*		1 3 *	1 3	0 8	0 8	0 01	0 01	0 15	0 15	0 04	0 04		
^116 Ovary*	*		*		*		*		*		*		*			
^117 Penis*	2 8 *		2 *		1 *		4 7 *		0 064 *		0 038 *		1 *		1 06	1 06
^118 Uterus*	*		*		*		*		*		*		*			
119 Uterine tube*	*		*		*		*		*		*		*			
120 Vagina*	*		*		*		*		*		*		*			
Total body	6000	6000	640	490	5300	5500	4300	4300	200	200	600	600	700	700		
Total of asterisked quantities	6000	6000	610	650	5400	5300	4000	3800	280	260	660	630	910	880		

(Asterisked quantities make up the totality of Reference Asian Man)

RAMM Reference Asian Man, Male RAMF Reference Asian Man, Female by G Tanaka

Table II. Physical properties, contents of blood, water, mineral, lipid and Protein of all organs and tissues for Reference Asian Man male(RAMM) and female(RAMF):1 year

[NIRS-M-85,95,115]

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
^1 Total body	11000	11000	830	750	10120	10205	7100	7100	600	500	1100	1000	2100	2200	1 08	1 08
1a Total soft tissue	9700	9700			9700	9700	6000	6000	500	500	1800	1800	1400	1400		
1b Total hard tissue	1300	1300			1300	1300										
2 Adipose tissue	1400	1320	20	20	1379	1299	200	200	2 7	2 6	1100	1100	68	66	0 94	0 94
3 Subcutaneous (hypodermis)*	740	720	11	10	728 *	709	110	110	1 5	1 4	600	600	38	37	0 99	0 99
4 Other separable*	500	480	8 6	8 2	491 *	471	70	67	0 94	0 91	400	400	24	23	0 94	0 94
5 Interstitial	120	120			120	120	19	19	0 24	0 24	96	96	6	6	0 94	0 94
6 Yellow marrow (skeleton)																
^7 Adrenals (2)*	4 5	4 2	0 3	0 3	4 2 *	3 9	3 2	2 9	*		0 5	0 5	0 4	0 4	1 04	1 04
8 Aorta*	17	17	*		17 *	17	12	12	0 25	0 24	0 21	0 21	4 5	4 5		
9 Contents*	32	32	30	30	*		26	26	0 32	0 32	0 17	0 17	5 8	5 8	1 08	1 08
^10 Blood	900	900	850	850			720	720	9	9	6	6 3	160	160	1 08	1 08
11 Plasma	500	500					460	460	4 6	4 6	3	3 2	33	33	1 05	1 05
12 Erythrocytes	400	400					260	260	4 4	4 4	3	3 1	130	130	1 11	1 11
13 Blood vessels*	34	34	*		34 *	34	26	26	0 21	0 21			7 9	7 9		
14 Contents (except aorta and pulmo	470	440	440	420	*		380	350	4 5	4 3	3 1	3 1	85	80	1 08	1 08
^15 Body fat	1300	1300			1300	1300					1300	1300			0 94	0 94
16 Essential	200	200			200	200					200	200			0 94	0 94
17 Nonessential	1100	1100			1100	1100					1100	1100			0 94	0 94
^18 Body water	7100	6800			7100	6800	7100	6800							1 02	1 02
19 Extracellular	3100	2900			3100	2900	3100	2900							1 02	1 02
20 Intracellular	4000	3900			4000	3900	4000	3900							1 02	1 02
21 Cartilage (skeleton)	170	170			170	170	130	130	7	6 9	2 1	2 1	26	26	1 12	1 12
22 Connective tissue	560	550			560	550	350	350	23	23	5 6	5 5	210	210	1 22	1 22
23 Tendons and fascia	230	230			230	230	140	140	9 4	9 3	2 3	2 3	86	85	1 22	1 22
24 Periarticular tissue	250	250			250	250	160	160	10	9 9	2 5	2 5	94	93	1 22	1 22
25 Other connective tissue	80	79			80	79	52	51	3 4	3 4	0 8	0 79	28	28	1 22	1 22
26 Separable connective tissue*	260	250	*		260 *	250	160	160	11	11	3	2 9	89	86	1 22	1 22
^27 Central nervous system*	1100	1100	19	17	1080 *	1082	860	850	16	16	120	120	87	86		
^28 Brain	1100	1090	21	20	1078	1069	850	840	16	16	120	120	85	84	1 05	1 05
29 Cerebrum	960	950			960	950	740	730	14	14	110	110	74	73		
30 Cerebellum	120	120			120	120	98	97	1 8	1 8	11	10	9 9	9 8		
31 Brain stem	20	20			20	20	15	15	0 3	0 3	2 2	2 2	1 6	1 6	1 06	1 06
32 Spinal cord	15	15			15	15	11	11	0 27	0 26	2	2	1 7	1 7	1 05	1 05
33 Contents (cerebrospinal fluid)*	21	21	*		21 *	21	21	21	0 13	0 13	*		0 0057	0 0057	1 03	1 03
^34 Eyes (2)*	7	6 9	*		7 *	6 9					*		*		1 05	1 05
^35 Lenses (2)	0 1	0 099			0 1	0 099	0 068	0 067	0 0004	0 0004	0 002	0 002	0 035	0 035	1 12	1 12

Table II (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
36 Gall bladder*	2	2	*		2 *	2	2	2	0 015	0 015	*		*			
37 Contents (bile)*	9	8 9	*		9 *	8 9	8 6	8 6	0 09	0 089	0 16	0 16	0 043	0 043	1 05	1 05
38 GI tract*	210	210	*		210 *	210	160	160	1 7	1 6	11	11	29	29	1 06	1 06
39 Contents (food plus digestive flui	180	180	*		180 *	180	160	160	*		*		*			
40 Esophagus	10	9 9			10	9 9	7 5	7 4	0 09	0 089					1 06	1 06
41 Stomach	30	30	0 94	0 93	29	29	21	21	0 24	0 23	1 9	1 9	4 1	4 1	1 07	1 07
42 Contents	50	50			50	50										
43 Intestine	170	170			170	170	130	130	1 3	1 3	11	11	21	20	1 06	1 06
44 Contents	130	130			130	130										
45 Small intestine	110	110			110	110	86	85	0 86	0 85	6 9	6 9	14	14	1 06	1 06
46 Contents	60	59			60	59										
47 Duodenum	9	8 9			9	8 9	7	6 9	0 072	0 071	0 56	0 55	1 2	1 2	1 07	1 07
48 Jejunum	49	49			49	49	38	37	0 38	0 37	3	3	6 2	6 1	1 06	1 06
49 Ileum	52	51			52	51	41	40	0 41	0 4	3 3	3 3	6 7	6 6	1 06	1 06
50 Large intestine	60	59			60	59	47	47	0 48	0 48	3 8	3 7	6 6	6 5	1 06	1 06
51 Contents	70	69			70	69										
52 Upper large intestine	33	33			33	33	26	26	0 26	0 26	2	2	4 4	4 4	1 06	1 06
53 Contents	40	40			40	40										
54 Ascending colon and cecum	15	15			15	15	12	12	0 12	0 12	0 94	0 93	2 1	2 1	1 06	1 06
55 Transverse colon	18	18			18	18	14	14	0 14	0 14	1 1	1 1	2 3	2 3	1 06	1 06
56 Lower large intestine	27	27			27	27	21	21	0 22	0 21	1 7	1 7	2 2	2 1	1 06	1 06
57 Contents	30	30			30	30										
58 Descending colon	15	15			15	15	12	12	0 12	0 12	1	0 99	0 64	0 63	1 06	1 06
59 Sigmoid colon	8	7 9			8	7 9	6 4	6 3	0 064	0 063	0 5	0 49	1	0 99	1 06	1 06
60 Rectum	4	4			4	4	3 2	3 2	0 032	0 032	0 24	0 24	0 52	0 51	1 06	1 06
61 Hair*	0 5	1	*		0 5 *	1	0 042	0 084	0 0026	0 0052	0 012	0 024	0 44	0 88	1 32	1 32
^62 Heart*	50	52	12	12	37 *	39	29	30	0 4	0 4	4 6	5 2	4 2	3 9	1 05	1 05
63 Contents (av)*	75	74	71	70	*		60	59	0 72	0 73	0 49	0 52	14	13	1 08	1 08
^64 Kidneys (2)*	66	63	9 8	9 5	56 *	53	43	42	0 5	0 5	6 8	7 2	5 5	4 7	1 07	1 07
65 Larynx*	5	5	*		5 *	5	3 3	3 3	0 15	0 15	*		*		1 10	1 10
^66 Liver*	380	370	42	41	335 *	327	260	250	3 9	3 8	41	44	33	28		
^67 Lung*	190	190	110	110	73 *	73	150	150	1 9	2	1 7	1 8	34	34	1 07 deflated	1 07
															0 26 inflated	0 26
68 Parenchyma (includes bronchial tree plus capillary blood)	80	80	14	14	65	65	61	61	0 88	0 88	0 99	0 99	14	14	1 02	1 02
^69 Blood (arterial and venous)	110	110	100	100			88	88	1 1	1 1	0 73	0 77	20	20	1 08	1 08
70 Bronchial tree	4 9	4 9			4 9	4 9										

Table II. (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
71 Lymphocytes	250	250			250	250										
72 Lymphatic tissue	110	110			110	110										
73 Lymph nodes (dissectible)*	46	46	0 62	0 63	45 *	45	*		*		*		*			
74 Miscellaneous*	370	610	*		370 *	610	*		*		*		*			
75 Solid soft tissue	100	150			100	150										
76 Fluid (synovial, pleural, etc)	270	460			270	460										
^77 Muscle (skeletal)*	4300	3700	69	59	4227 *	3637	3200	3200	48	41	74	63	690	690	1 06	1 06
78 Nails (20)*	0 56	0 55	*		*		0 037	0 037	*		*		*		1 32	1 32
79 Pancreas*	23	20	2 7	2 3	20 *	18	15	13	0 4	0 3	2 5	2 3	2 1	1 6	1 07	1 07
80 Parathyroid (4)*	0 02	0 02	*		0 02 *	0 02	*		*		*		*		1 07	1 07
81 Pineal*	0 03	0 03	*		0 03 *	0 03	*		*		*		*		1 09	1 09
^82 Pituitary*	0 22	0 25	0 02	0 03	0 20 *	0 22	0 15	0 17	0 0035	0 004	0 04	0 03	0 02	0 02		
83 Prostate*	1 *		*		1 *		0 9 *		0 031 *		0 023 *		0 26 *		1 07	1 07
83a Contents*	*		*		*		*		*		*		*			
84 Salivary glands (6)*	16	16	1 1	1 1	14 8 *	14 8	11	11	*		*		*		1 07	1 07
85 Parotid (2)	9	9	0 77	0 76	8 2	8 2									1 07	1 07
86 Submaxillary (2)	5	5	0 44	0 43	4 5	4 5									1 07	1 07
87 Sublingual (2)	2	2	0 13	0 13	1 9	1 9									1 07	1 07
^88 Skeleton*	1300	1300	39	38	1259 *	1260	440	440	460	460	88	87	310	310	1 43	1 43
^89 Bone	850	840	30	30	818	808	150	150	450	450	8 5	8 4	230	230	2 24	2 24
90 Cortical	670	660			670	660									1 88	1 88
91 Trabecular	180	180			180	180									1 10	1 10
92 Red marrow	190	190	8 6	8 5	181	181	76	75	1 1	1 1	76	75	38	38	1 05	1 05
93 Yellow marrow																
94 Cartilage	170	170			170	170	130	130	7	6 9	2 1	2 1	26	26	1 12	1 12
95 Periarticular tissue (skeletal)	130	130			130	130	84	83	5 4	5 3	1 6	1 6	20	20	1 12	1 12
96 Skin*	450	440	8 8	8 6	441 *	431	280	280	3 2	3 1	36	35	130	130	1 12	1 12
97 Epidermis	20	20			20	20									1 17	1 17
98 Dermis	430	420			430	420									1 14	1 14
^99 Hypodermis (see adipose tissue)	740	720			740	720									0 99	0 99
100 Spleen*	36	33	17	16	18 *	16	15	13	0 2	0 2	1 7	1 7	2 2	1 8	1 08	1 08
101 Teeth (32)*	8 3	8 1	*		8 3 *	8 1	0 85	0 79	6 2	6 1	*		0 17	0 13	2 14	2 14
102 Enamel	2	2			2	2	0 056	0 055	1 9	1 9			0 024	0 024		
103 Dentin	6	5 9			6	5 9	0 65	0 65	4 2	4 2			0 026	0 026		
104 Pulp	0 3	0 2			0 3	0 2	0 14	0 092	0 02	0 013	0 002	0 0013	0 12	0 079		
105 Testes (2)*	2 6 *		0 2 *		2 4 *		1 9 *		0 029 *		0 3 *		0 2 *		1 06	1 06

Table II (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF
^106 Thymus*	27	28	6	6 1	21 *	22	16	16	0 1	0 1	2 8	3 1	2	1 8	1 05	1 05
^107 Thyroid*	2 3	2 4	0 3	0 3	2 0 *	2 1	1 6	1 6	0 028	0 03	0 2	0 3	0 2	0 2	1 07	1 07
108 Tongue*	13	13	*		13 *	13	8 7	8 6	0 14	0 13	2 1	2 1	2 1	2 1		
109 Tonsils (2 palatine)*	*		*		*		*		*		*		*			
110 Trachea*	2	2	*		2 *	2	1 1	1 1	0 031	0 031	*		*		1 10	1 10
111 Ureters (2)*	3	3	*		3 *	3	2 1	2	*		*		*			
112 Urethra*	2 1	2	*		2 1 *	2	1 5	1 4	*		*		*			
113 Urinary bladder*	8	7 9	*		8 *	7 9	5 2	5 1	0 064	0 063	*		*			
114 Contents (urine)*	19	19	*		19 *	19	18	18	0 2	0 2	*		1 2	1 1	1 04	1 04
^115 Breast*	2	2	*		2 *	2	1 6	1 6	0 02	0 02	0 3	0 3	0 08	0 079		
^116 Ovary*	*		*		*		*		*		*		*			
^117 Penis*	3 *		1 *		2 *		2 *		0 096 *		0 057 *		1 *		1 06	
^118 Uterus*	*		*		*		*		*		*		*			
119 Uterine tube*	*		*		*		*		*		*		*			
120 Vagina*	*		*		*		*		*		*		*			
Total body	11000	11000	830	750	10000	10000	7100	7100	600	500	1100	1000	2100	2200		
Total of asterisked quantities	11000	11000	910	850	10000	9600	6600	6500	570	560	1400	1400	1600	1600		

(Asterisked quantities make up the totality of Reference Asian Man)

RAMM Reference Asian Man, Male RAMF Reference Asian Man, Female by G Tanaka

Table III. Physical properties, contents of blood, water, mineral, lipid and Protein of all organs and tissues for Reference Asian Man male(RAMM) and female(RAMF):5 years

[NIRS-M-85,95,115]

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^1 Total body	19000	19000	1400	1400	17516	17516	12000	12000	1300	1300	2000	2000	3300	3200	1 08	1 08
1a Total soft tissue	17000	17000			17000	17000	11000	11000	1100	1100	1800	1800	2900	2800		
1b Total hard tissue	2200	2200			2200	2200										
2 Adipose tissue	1900	1900	160	100	1730	1794	390	390	5 2	4 5	1400	1400	130	120	0 94	0 94
3 Subcutaneous (hypodermis)*	1100	1100	80	50	1015 *	1047	220	220	3	3	800	800	76	76	0 99	0 99
4 Other separable*	670	670	50	33	617 *	635	140	140	1 9	1 2	480	480	49	31	0 94	0 94
5 Interstitial	130	130			130	130	31	31	0 3	0 3	90	90	10	10	0 94	0 94
6 Yellow marrow (skeleton)																
^7 Adrenals (2)*	5 6	5 6	0 4	0 4	5 2 *	5 2	3 6	3 6	0 038	0 038	0 9	1	0 6	0 5	1 04	1 04
8 Aorta*	29	28	*		29 *	28	20	20	0 42	0 41	0 35	0 35	7 7	7 6		
9 Contents*	55	54	52	51	*		45	44	0 55	0 54	0 29	0 29	10	9 8	1 08	1 08
^10 Blood	1500	1500	1400	1400			1200	1200	14	14	9 7	13	270	260	1 08	1 08
11 Plasma	850	830					780	770	7 4	7 3	6 3	8 5	56	47	1 05	1 05
12 Erythrocytes	650	640					420	410	7 1	7	3 4	4 5	220	220	1 11	1 11
13 Blood vessels*	59	58	*		59 *	58	46	45	0 36	0 35			14	13		
14 Contents (except aorta and pulmo	850	800	800	760	*		680	650	8 2	7 8	5 7	7 4	150	140	1 08	1 08
^15 Body fat	2000	2000			2000	2000					2000	2000			0 94	0 94
16 Essential	230	230			230	230					230	230			0 94	0 94
17 Nonessential	1800	1800			1800	1800					1800	1800			0 94	0 94
^18 Body water	12000	12000			12000	12000	12000	12000							1 02	1 02
19 Extracellular	5000	4850			5000	4850	5000	4850							1 02	1 02
20 Intracellular	7000	6750			7000	6750	7000	6750							1 02	1 02
21 Cartilage (skeleton)	290	280			290	280	230	230	12	12	3 5	3 5	45	44	1 12	1 12
22 Connective tissue	950	930			950	930	590	590	39	39	9 5	9 3	360	350	1 22	1 22
23 Tendons and fascia	390	380			390	380	240	240	16	16	3 9	3 8	150	150	1 22	1 22
24 Periarticular tissue	430	420			430	420	270	270	18	18	4 3	4 2	160	160	1 22	1 22
25 Other connective tissue	130	130			130	130	85	83	5 5	5 4	1 3	1 3	46	45	1 22	1 22
26 Separable connective tissue*	460	450	*		460 *	450	280	270	19	19	5 3	5 2	160	160	1 22	1 22
^27 Central nervous system*	1400	1300	22	23	1377 *	1276	1100	1100	21	19	150	150	110	100		
^28 Brain	1400	1300	27	25	1372	1274	1100	1100	20	19	150	150	110	100	1 05	1 05
29 Cerebrum	1220	1150			1220	1150	930	910	18	17	130	130	93	88		
30 Cerebellum	150	120			150	120	120	120	2 3	1 8	13	13	12	9 9		
31 Brain stem	30	30			30	30	21	21	0 42	0 42	3 1	3 1	2 2	2 2	1 06	1 06
32 Spinal cord	20	20			20	20	15	15	0 36	0 36	2 7	2 7	2 3	2 3	1 05	1 05
33 Contents (cerebrospinal fluid)*	36	35	*		36 *	35	36	35	0 23	0 22	*		0 0098	0 0096	1 03	1 03
^34 Eyes (2)*	14	11	*		14 *	11						d	*		1 05	1 05
^35 Lenses (2)	0 38	0 3			0 38	0 30	0 2	0 16	0 0012	0 00095	0 006	0 0047	0 11	0 083	1 12	1 12

Table III (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
36 Gall bladder*	3	2 9	*		3 *	2 9	3	2 9	0 023	0 022	*		*			
37 Contents (bile)*	16	16	*		16 *	16	15	15	0 16	0 16	0 29	0 28	0 077	0 075	1 05	1 05
38 GI tract*	360	350	*		360 *	350	280	270	2 8	2 8	22	21	42	41	1 06	1 06
39 Contents (food plus digestive flui	310	310	*		310 *	310	280	270	*		*		*			
40 Esophagus	13	13			13	13	9 8	9 6	0 12	0 11					1 06	1 06
41 Stomach	47	46	2	2	45	44	34	33	0 37	0 36	2 9	2 9	6 4	6 3	1 07	1 07
42 Contents	80	80			80	80										
43 Intestine	300	290			300	290	230	230	2 3	2 3	19	18	36	35	1 06	1 06
44 Contents	230	230			230	230										
45 Small intestine	190	190			190	190	150	140	1 5	1 5	12	12	24	24	1 06	1 06
46 Contents	110	110			110	110										
47 Duodenum	15	15			15	15	12	11	0 12	0 12	0 93	0 91	2	1 9	1 07	1 07
48 Jejunum	85	83			85	83	65	64	0 65	0 64	5 2	5 1	11	11	1 06	1 06
49 Ileum	90	88			90	88	71	69	0 71	0 69	5 8	5 7	12	11	1 06	1 06
50 Large intestine	110	110			110	110	87	85	0 84	0 82	6 7	6 5	11	11	1 06	1 06
51 Contents	120	120			120	120										
52 Upper large intestine	60	58			60	58	47	46	0 48	0 47	3 7	3 7	8	7 8	1 06	1 06
53 Contents	70	69			70	69										
54 Ascending colon and cecum	27	26			27	26	21	21	0 22	0 21	1 7	1 7	3 7	3 6	1 06	1 06
55 Transverse colon	33	32			33	32	26	26	0 26	0 26	2	2	4 3	4 2	1 06	1 06
56 Lower large intestine	49	48			49	48	40	39	0 36	0 35	2 9	2 9	3 5	3 4	1 06	1 06
57 Contents	50	49			50	49										
58 Descending colon	27	26			27	26	21	21	0 22	0 21	1 8	1 8	1 1	1 1	1 06	1 06
59 Sigmoid colon	16	16			16	16	13	13	0 13	0 13	0 99	0 97	2 1	2	1 06	1 06
60 Rectum	6	6			6	6	5 5	5 5	0 016	0 016	0 12	0 12	0 26	0 25	1 06	1 06
61 Hair*	5	4 9	d	d	5 *	4 9	0 42	0 41	0 026	0 025	0 12	0 12	4 4	4 3	1 32	1 32
^62 Heart*	100	100	24	24	75 *	75	59	59	1 2	1 2	8 3	9 1	9 7	8 9	1 05	1 05
63 Contents (av)*	130	130	120	120	d *	d	100	100	1 3	1 3	0 85	1 2	24	23	1 08	1 08
^64 Kidneys (2)*	120	100	18	16	101 *	83	73	65	1 3	1 2	12	12	14	11	1 07	1 07
65 Larynx*	9	8 8	d	d	9 *	8 8	6	5 9	0 27	0 26	d	d	d	d	1 10	1 10
^66 Liver*	630	600	70	67	556 *	529	410	400	8 1	7 7	67	71	69	60	d	d
^67 Lung*	320	310	200	170	108 *	130	250	250	3 3	3 2	2 9	3 3	57	56	1 07 deflated	1 07
															0 26 inflated	0 26
68 Parenchyma (includes bronchial tree plus capillary blood)	130	130	22	22	107	107	99	97	1 4	1 4	1 6	1 6	23	22	d	d
															1 02	1 02
^69 Blood (arterial and venous)	190	190	180	180			150	150	1 8	1 8	1 3	1 7	34	33	1 08	1 08
70 Bronchial tree	8 5	8 3			8 5	8 3										

Table III (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
71 Lymphocytes	420	410			420	410										
72 Lymphatic tissue	200	200			200	200										
73 Lymph nodes (dissectible)*	72	71	1	1	71 *	70	*		*		*		*			
74 Miscellaneous*	700	590	*		700 *	590	*		*		*		*			
75 Solid soft tissue	600	500			600	500										
76 Fluid (synovial, pleural, etc.)	100	88			100	88	68	60								
^77 Muscle (skeletal)*	9300	9200	120	120	9173 *	9073	5100	5000	77	76	120	120	1100	1100	1 06	1 06
78 Nails (20)*	0 98	0 96	*		0 98 *	0 96	0 065	0 064	*		*		*		1 32	1 32
79 Pancreas*	44	40	5 3	4 7	38 *	35	29	26	1	0 9	5	4 9	4 3	3 4	1 07	1 07
80 Parathyroid (4)*	0 11	0 14	*		0 11 *	0 14	*		*		*		*		1 07	1 07
81 Pineal*	0 17	0 14	*		0 17 *	0 14	*		*		*		*		1 09	1 09
^82 Pituitary*	0 29	0 3	0 03	0 03	0 26 *	0 27	0 2	0 2	*		0 04	0 04	0 02	0 02		
83 Prostate*	1 *		*		1 *		*		*		*		*		1 07	1 07
83a Contents*	0 34 *		*		0 34 *		*		*		*		*			
84 Salivary glands (6)*	27	26	2 5	2 5	24 *	23	20	20	*		*		*		1 07	1 07
85 Parotid (2)	16	16	1 7	1 7	14	14									1 07	1 07
86 Submaxillary (2)	8	7 8	0 9	0 9	7 0	6 8									1 07	1 07
87 Sublingual (2)	3	2 9	0 25	0 25	2 7	2 6									1 07	1 07
^88 Skeleton*	2200	2200	50	50	2147 *	2147	740	740	780	770	140	140	500	480	1 43	1 43
^89 Bone	1400	1400	35	35	1363	1363	240	240	760	750	12	12	350	340	2 24	2 24
90 Cortical	1100	1100	d	d	1100	1100	170	170	610	600	9 2	9	280	270	1 88	1 88
91 Trabecular	300	290			300	290	70	69	150	150	3	2 9	73	72	1 10	1 10
92 Red marrow	310	300	15	15	294	284	120	120	1 8	1 8	120	120	62	61	1 05	1 05
93 Yellow marrow																
94 Cartilage	290	280			290	280	230	230	12	12	3 5	3 5	45	44	1 12	1 12
95 Periarticular tissue (skeletal)	240	240			240	240	150	150	9 9	9 7	3	2 9	38	37	1 12	1 12
96 Skin*	780	770	18	18	761 *	751	490	480	5 5	5 4	62	61	230	230	1 12	1 12
97 Epidermis	33	32			33	32									1 17	1 17
98 Dermis	750	740			750	740									1 14	1 14
^99 Hypodermis (see adipose tissue)	1100	1100			1100	1100									0 99	0 99
100 Spleen*	59	58	29	28	28 *	28	23	23	0 5	0 5	1 9	2	5 3	5 1	1 08	1 08
101 Teeth (32)*	43	34	*		43 *	34	1 5	1 3	11	8 3	*		0 28	0 26	2 14	2 14
102 Enamel	9	6			9	6	0 084	0 056	2 9	1 9			0 036	0 024		
103 Dentin	33	27			33	27	1 2	0 98	7 8	6 4			0 049	0 04		
104 Pulp	1	1			1	1	0 23	0 23	0 033	0 033	0 0033	0 0033	0 2	0 2		
105 Testes (2)*	3 1 *		0 2 *		2 9 *		2 2 *		0 1 *		0 3 *		0 3 *		1 06	1 06

Table III (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^106 Thymus*	35	31	7 6	6 8	27 *	24	18	16	0 2	0 2	5 8	5 7	2 9	2	1 05	1 05
^107 Thyroid*	4 5	4 6	0 6	0 6	4 *	4	2 8	2 9	0 1	0 1	0 5	0 5	0 5	0 5	1 07	1 07
108 Tongue*	64	50	*		64 *	50	15	15	0 23	0 18	3 6	2 8	3 6	2 8		
109 Tonsils (2 palatine)*	1	0 98	*		1 *	1	0 75	0 74	*		*		*			
110 Trachea*	3 2	2 9	*		3 *	3	1 7	1 5	0 047	0 043	*		*		1 10	1 10
111 Ureters (2)*	5 1	4 9	*		5 *	5	3 4	3 3	*		*		*			
112 Urethra*	3 3	2 9	*		3 *	3	2 3	2	*		*		*			
113 Urinary bladder*	13	13	*		13 *	13	8 5	8 3	0 1	0 1	*		*			
114 Contents (urine)*	33	32	*		33 *	32	31	30	0 36	0 35	*		2	2	1 04	1 04
^115 Breast*	3	3	*		3 *	3	2 4	2 4	0 03	0 03	0 45	0 45	0 12	0 12		
^116 Ovary*		0 5	*		*	0 5	*		*		*		*			
^117 Penis*	4 *		2 *		2 *		2 *		0 1 *		0 1 *		1 8 *		1 06	
^118 Uterus*		5 9	*		*	5 9		3		0 15		0 15		2 7		1 06
119 Uterine tube*		0 84	*		*	0 8		0 42		0 021		0 021		0 38		1 06
120 Vagina*		2 1	*		*	2 1		1 1		0 053		0 053		0 95		1 06
Total body	19000	19000	1400	1400	18000	18000	12000	12000	1300	1300	2000	2000	3300	3200		
Total of asterisked quantities	20000	20000	1700	1500	18000	18000	11000	11000	950	930	1900	1900	2700	2600		

(Asterisked quantities make up the totality of Reference Asian Man)

RAMM Reference Asian Man, Male RAMF Reference Asian Man, Female by G Tanaka

Table IV. Physical properties, contents of blood, water, mineral, lipid and Protein of all organs and tissues for Reference Asian Man male(RAMM) and female(RAMF):10 years

[NIRS-M-85,95,115]

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^1 Total body	30000	31000	2400	2500	27456	28350	19000	19000	2200	2200	4500	4700	4300	4300	1 06	1 06
1a Total soft tissue	25400	26600			25000	27000	16000	17000	1900	1900	3800	4000	3700	3700		
1b Total hard tissue	4600	4400			4600	4400										
2 Adipose tissue	4800	5100	89	91	4706	5003	1300	1300	16	17	3300	3600	300	300	0 92	0 92
3 Subcutaneous (hypodermis)*	2400	2700	45	46	2352 *	2651	650	700	8 5	8 8	1600	1900	160	170	0 97	0 97
4 Other separable*	1500	1800	35	37	1463 *	1761	400	420	5 4	5 6	1100	1300	90	100	0 92	0 92
5 Interstitial	300	200			300	200	70	50	1 3	1 4	200	130	25	15	0 92	0 92
6 Yellow marrow (skeleton)	600	400	6	6 2	594	393	140	100	1 2	1	450	300	24	15	0 98	0 98
^7 Adrenals (2)*	8 1	8 1	0 6	0 6	7 5 *	7 5	5	5	0 063	0 063	1 5	1 7	1	0 8	1 02	1 02
8 Aorta*	48	49			48 *	49	35	36	0 8	0 82	0 59	0 6	12	12		
9 Contents*	90	93	85	88	*		75	78	1	1	0 48	0 49	13	14	1 06	1 06
^10 Blood	2400	2500	2300	2400			1900	2000	23	24	16	23	440	480	1 06	1 06
11 Plasma	1400	1400					1300	1300	13	14	10	15	110	130	1 03	1 03
12 Erythrocytes	1000	1100					660	720	10	10	5 2	7 7	330	350	1 09	1 09
13 Blood vessels*	96	100	*		96 *	100	75	78	0 59	0 61			22	23		
14 Contents (except aorta and pulmo	1300	1300	1200	1300	*		1000	1100	12	13	8 7	12	240	240	1 06	1 06
^15 Body fat	4500	4700			4500	4700					4500	4700			0 92	0 92
16 Essential	570	480			570	480					570	480			0 92	0 92
17 Nonessential	3900	4200			3900	4200					3900	4200			0 92	0 92
^18 Body water	19000	19000			19000	19000	19000	19000							1 00	1 00
19 Extracellular	8300	8430			8300	8430	8300	8430							1 00	1 00
20 Intracellular	11000	11000			11000	11000	11000	11000							1 00	1 00
21 Cartilage (skeleton)	480	360			480	360	380	280	26	20	5 9	4 4	75	70	1 10	1 10
22 Connective tissue	1500	1100			1500	1100	920	640	79	60	15	11	490	430	1 20	1 20
23 Tendons and fascia	620	470			620	470	380	250	33	25	6 2	4 7	200	190	1 20	1 20
24 Periarticular tissue	680	520			680	520	400	290	35	27	6 8	5 2	240	200	1 20	1 20
25 Other connective tissue	200	150			200	150	140	100	11	8 3	2	1 5	50	40	1 20	1 20
26 Separable connective tissue*	750	770	*		750 *	770	470	490	41	42	8 6	8 8	230	230	1 20	1 20
^27 Central nervous system*	1500	1300	22	23	1477 *	1276	1200	920	29	30	160	120	120	120		
^28 Brain	1470	1320	26	25	1442	1293	1100	900	29	30	160	120	110	120	1 03	1 03
29 Cerebrum	1280	1130			1280	1130	970	720	25	26	140	100	97	100		
30 Cerebellum	160	160			160	160	150	150	3 2	3 3	14	14	13	13		
31 Brain stem	25	25			25	25	22	22	0 5	0 5	3 2	3 2	2 3	2 3	1 04	1 04
32 Spinal cord	30	30			30	30	24	24	0 5	0 5	3	3	2 6	2 6	1 03	1 03
33 Contents (cerebrospinal fluid)*	59	60	*		59 *	60	65	66	0 5	0 51	*		0 016	0 016	1 01	1 01
^34 Eyes (2)*	15	11	*		15 *	11					*		*		1 03	1 03
^35 Lenses (2)	0 4	0 3			0 4	0 3	0 2	0 2	0 0012	0 0012	0 006	0 006	0 11	0 09	1 10	1 10

Table IV (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
36 Gall bladder*	4	4	*		4 *	4	4	4	0 03	0 03	*		*			
37 Contents (bile)*	27	29	*		27 *	29	30	32	0 4	0 43	0 49	0 52	0 13	0 14	1 03	1 03
38 GI tract*	600	610	*		600 *	610	470	480	6 1	6 2	36	37	* 71	62	1 04	1 04
39 Contents (food plus digestive flui	510	520	*		510 *	520	*		*		*		*			
40 Esophagus	25	25			25	25	19	19	0 3	0 3					1 04	1 04
41 Stomach	75	75	2 4	2 4	72	72	54	54	0 7	0 7	4 7	4 7	10	10	1 05	1 05
42 Contents	130	130			130	130										
43 Intestine	500	510			500	510	400	400	5 1	5 2	32	32	61	52	1 04	1 04
44 Contents	380	390			380	390										
45 Small intestine	320	330			320	330	250	260	3	3 1	20	20	41	32	1 04	1 04
46 Contents	190	190			190	190										
47 Duodenum	30	30			30	30	23	23	0 3	0 3	1 9	1 9	3 9	3 9	1 05	1 05
48 Jejunum	140	150			140	150	110	110	1 4	1 5	8 6	8 9	18	14	1 04	1 04
49 Ileum	150	150			150	150	120	120	1 3	1 3	9 6	9 6	19	14	1 04	1 04
50 Large intestine	180	180			180	180	140	150	2 1	2 1	11	12	20	20	1 04	1 04
51 Contents	190	200			190	200										
52 Upper large intestine	100	100			100	100	78	79	1	1	6 2	6 3	13	13	1 04	1 04
53 Contents	120	130			120	130										
54 Ascending colon and cecum	45	46			45	46	35	36	0 5	0 51	2 8	2 9	6 2	6 3	1 04	1 04
55 Transverse colon	55	55			55	55	43	43	0 5	0 5	3 4	3 4	7 2	7 2	1 04	1 04
56 Lower large intestine	80	83			80	83	64	66	1 1	1 1	5 2	5 4	6 6	6 9	1 04	1 04
57 Contents	70	70			70	70										
58 Descending colon	43	45			43	45	34	36	0 5	0 52	2 9	3	1 8	1 9	1 04	1 04
59 Sigmoid colon	27	28			27	28	22	23	0 4	0 41	1 7	1 7	3 5	3 6	1 04	1 04
60 Rectum	10	10			10	10	8	8	0 2	0 2	0 6	0 6	1 3	1 3	1 04	1 04
61 Hair*	13	39	*		13 *	39	1 1	3 3	0 2	0 6	0 31	0 94	11	33	1 30	1 30
^62 Heart*	180	180	42	43	135 *	134	98	100	2 2	2 2	13	15	21	20	1 03	1 03
63 Contents (av)*	210	220	200	210	*		170	180	2	2 1	1 5	1 9	38	39	1 06	1 06
^64 Kidneys (2)*	180	170	28	25	150 *	144	110	100	2 1	1 9	19	19	23	20	1 05	1 05
65 Larynx*	14	15	*		14 *	15	9	9 6	0 42	0 45	*		*		1 08	1 08
^66 Liver*	1000	970	110	110	883 *	853	630	620	14	14	110	110	140	140		
^67 Lung*	520	540	330	290	170 *	233	410	380	5 3	5 5	4 7	5 7	93	85	1 05	1 05
															deflated	
															0 26	0 26
															inflated	
68 Parenchyma (includes bronchial tree plus capillary blood)	210	220	30	31	178	187	160	120	2 3	2 4	2 6	2 7	37	28	1 00	1 00
^69 Blood (arterial and venous)	310	320	290	300			250	260	3	3 1	2 1	2 9	56	57	1 06	1 06
70 Bronchial tree	14	15			14	15										

Table IV (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
71 Lymphocytes	690	700			690	700										
72 Lymphatic tissue	320	330			320	330										
73 Lymph nodes (dissectible)*	120	130	1 6	1 7	118 *	128	*		*		*		*			
74 Miscellaneous*	840	1300	*		840 *	1300	*		*		*		*			
75 Solid soft tissue	690	1200			690	1200										
76 Fluid (synovial, pleural, etc)	150	110			150	110	110	83								
^77 Muscle (skeletal)*	12000	12000	150	150	11841 *	11841	8500	8500	120	120	150	140	1700	1700	1 04	1 04
78 Nails (20)*	2	2	*		2 *	2	0 13	0 13	*		*		*		1 30	1 30
79 Pancreas*	71	65	8 4	7 8	62 *	57	44	40	1 5	1 4	8 2	8 4	8 9	7 5	1 05	1 05
80 Parathyroid (4)*	0 12	0 14	*		0 12 *	0 14	*		*		*		*		1 05	1 05
81 Pineal*	0 18	0 14	*		0 18 *	0 14	*		*		*		*		1 07	1 07
^82 Pituitary*	0 4	0 45	0 04	0 05	0 36 *	0 40	0 27	0 3	0 01	0 01	0 05	0 07	0 03	0 03		
83 Prostate*	1 5 *		*		1 5 *		*		*		*		*		1 05	1 05
83a Contents*	0 51 *		*		0 51 *		*		*		*		*			
84 Salivary glands (6)*	44	46	3 3	3 3	41 *	43	33	25	*		*		*		1 05	1 05
85 Parotid (2)	26	26	2 2	2 2	24	24									1 05	1 05
86 Submaxillary (2)	13	15	1 1	1 3	12	14									1 05	1 05
87 Sublingual (2)	5	5	0 33	0 33	5	5									1 05	1 05
^88 Skeleton*	4600	4400	100	100	4494 *	4294	1500	1100	1800	1800	760	540	900	730	1 40	1 40
^89 Bone	2400	2500	70	73	2326	2423	410	300	1800	1700	21	22	600	470	2 20	2 20
90 Cortical	1900	2000			1900	2000	290	210	1500	1400	16	17	480	350	1 85	1 85
91 Trabecular	500	520			500	520	120	90	330	330	5	5 2	120	120	1 08	1 08
92 Red marrow	700	720	32	32	666	686	280	210	5	5 1	280	210	140	110	1 03	1 03
93 Yellow marrow	600	400	6 9	7 2	593	392	140	100	1 2	1	450	300	24	15	0 98	0 98
94 Cartilage	480	360			480	360	380	280	26	20	5 9	4 4	75	70	1 10	1 10
95 Periarticular tissue (skeletal)	380	390			380	390	240	180	20	21	4 8	4 9	60	61	1 10	1 10
96 Skin*	1200	1200	24	25	1175 *	1174	950	950	11	12	95	100	350	260	1 10	1 10
97 Epidermis	50	52			50	52									1 15	1 15
98 Dermis	1150	1200			1200	1200									1 12	1 12
^99 Hypodermis (see adipose tissue)	2400	2700			2400	2700									0 97	0 97
100 Spleen*	88	87	43	42	42 *	42	33	33	0 8	0 8	2	2 1	9 5	9 2	1 06	1 06
101 Teeth (32)*	45	34	*		45 *	34	2 5	2 5	19	16	*		0 45	0 45	2 10	2 10
102 Enamel	10	7			10	7	0 17	0 17	5 8	5 8			0 072	0 072		
103 Dentin	34	26			34	26	2	2	13	10			0 079	0 079		
104 Pulp	1	1			1	1	0 35	0 35	0 05	0 05	0 005	0 005	0 3	0 3		
105 Testes (2)*	4 7 *		0 4 *		4 3 *		3 3 *		0 1 *		0 5 *		0 6 *		1 04	1 04

Table IV (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^106 Thymus*	42	32	9 2	7 2	32 *	24	21	16	0 2	0 2	7 9	6 8	3 7	2 3	1 03	1 03
^107 Thyroid*	8 4	8 6	1 1	1 2	7.2 *	7.3	5 2	5.3	0 1	0 1	0 9	1	1 1	1	1 05	1 05
108 Tongue*	67	51	*		67 *	51	28	28	0 38	0 38	5 9	5 9	5 9	5 9		
109 Tonsils (2 palatine)*	1	1	*		1 *	1	0 75	0 75	*		*		*			
110 Trachea*	5	5	*		5 *	5	2 8	2 8	0 08	0 08	*		*		1 08	1 08
111 Ureters (2)*	8	8 6	*		8 *	8 6	5 5	5 9	*		*		*			
112 Urethra*	5	5	*		5 *	5	3 8	3 8	*		*		*			
113 Urinary bladder*	21	21	*		21 *	21	14	14	0 17	0 17	*		*			
114 Contents (urine)*	54	54	*		54 *	54	50	50	0 58	0 58	*		3 3	3 3	1 02	1 02
^115 Breast*	2 8	38	*		2 8 *	38	4	120	0 05	1 5	0 75	23	0 2	6		
^116 Ovary*		1 4	*		*	1 4	*		*		*		*			
^117 Penis*	6 *		*		4 *		3 1 *		0 2 *		*		2 6 *		1 04	1 04
^118 Uterus*		8 9	*		*	8 9		4 6		0 3		0 15		3 9		
119 Uterine tube*		1 3	*		*	1 3		0 67		0 043		0 022		0 56		
120 Vagina*		3 2	*		*	3 2		1 7		0 11		0 053		1 4		
Total body	30000	31000	2400	2500	27000	28000	19000	19000	2200	2200	4500	4700	4300	4300		
Total of asterisked quantities	30000	31000	2500	2500	28000	28000	18000	18000	2200	2200	4100	4500	4200	4100		

(Asterisked quantities make up the totality of Reference Asian Man)

RAMM Reference Asian Man, Male RAMF Reference Asian Man, Female by G Tanaka

Table V. Physical properties, contents of blood, water, mineral, lipid and Protein of all organs and tissues for Reference Asian Man male(RAMM) and female(RAMF):15 years

[NIRS-M-85,95,115]

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^1 Total body	54000	49000	4100	3000	49654	45820	36000	31000	2900	2400	7500	9500	7300	6900	1 07	1 05
1a Total soft tissue	46700	43400			47000	43000	32000	25000	310	260	8700	9000	6700	5500		
1b Total hard tissue	7300	5600			7300	5600										
2 Adipose tissue	9500	8850	140	105	9352	8739	1800	1600	20	15	7100	6800	470	420	0 93	0 91
3 Subcutaneous (hypodermis)*	4900	4600	73	66	4823 *	4530	850	800	10	7 6	3700	3600	240	230	0 98	0 96
4 Other separable*	3100	2900	55	50	3042 *	2847	600	550	6	4 7	2300	2200	150	130	0 93	0 91
5 Interstitial	500	450			500	450	100	90	1 4	1 1	360	340	35	28	0 93	0 91
6 Yellow marrow (skeleton)	1000	900	11	8 5	988	891	200	180	2 2	1 7	750	690	44	34	0 99	0 97
^7 Adrenals (2)*	11	11	0 9	0 8	10 *	10	6 5	6 1	0 1	0 1	2 2	2 8	1 7	1 4	1 03	1 01
8 Aorta*	84	63	*		84 *	63	59	44	1 2	0 92	1	1 2	20	17		
9 Contents*	160	120	150	120	*		130	99	1 6	1 2	0 85	1	25	22	1 07	1 05
^10 Blood	4300	3200	4100	3000			3400	2600	41	31	29	29	780	570	1 07	1 05
11 Plasma	2400	2000					2200	1800	21	18	18	19	160	150	1 04	1 02
12 Erythrocytes	1900	1200					1200	750	20	13	10	10	620	430	1 10	1 08
13 Blood vessels*	170	130	*		170 *	130	130	100	1	0 81			40	31		
14 Contents (except aorta and pulmo	1900	1500	1800	1400	*		1500	1200	18	15	13	14	340	270	1 07	1 05
^15 Body fat	7500	9500			7500	9500					7500	9500			0 93	0 91
16 Essential	900	700			900	700					900	700			0 93	0 91
17 Nonessential	6600	8800			6600	8800					6600	8800			0 93	0 91
^18 Body water	36000	31000			36000	31000	36000	31000							1 01	0 99
19 Extracellular	16000	12800			16000	12800	16000	12800							1 01	0 99
20 Intracellular	20000	18200			20000	18200	20000	18200							1 01	0 99
21 Cartilage (skeleton)	840	640			840	640	650	490	34	26	10	12	130	99	1 11	1 09
22 Connective tissue	2700	2000			2700	2000	1700	1300	110	85	27	31	1000	760	1 21	1 19
23 Tendons and fascia	1100	830			1100	830	690	520	45	34	11	12	410	310	1 21	1 19
24 Periarticular tissue	1200	910			1200	910	760	580	50	38	12	14	450	340	1 21	1 19
25 Other connective tissue	400	300			400	300	260	200	17	13	4	5	140	110	1 21	1 19
26 Separable connective tissue*	1300	1000	*		1300 *	1000	870	620	54	41	15	18	420	380	1 21	1 19
^27 Central nervous system*	1500	1400	25	23	1474 *	1376	1200	880	22	17	160	170	120	89		
^28 Brain	1470	1320	28	26	1440	1293	1100	860	22	16	160	170	110	86	1 04	1 02
29 Cerebrum	1280	1130			1280	1130	980	740	19	14	140	150	98	75		
30 Cerebellum	160	160			160	160	130	98	2 4	1 8	14	16	13	9 9		
31 Brain stem	30	30			30	30	23	18	0 45	0 35	3 3	4	2 4	1 8	1 05	1 03
32 Spinal cord	30	30			30	30	24	20	0 4	0 33	3	3 5	2 6	2 2	1 04	1 02
33 Contents (cerebrospinal fluid)*	100	75	*		100 *	75	100	75	0 64	0 48	*		0 027	0 021	1 02	1 00
^34 Eyes (2)*	15	12	*		15 *	12					*		*		1 04	1 02
^35 Lenses (2)	0 4	0 33			0 4	0 3	0 2	0 2	0 0012	0 0012	0 006	0 006	0 11	0 11	1 11	1 09

Table V (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
36 Gall bladder*	8	6 1	*		8 0 *	6 1	7 9	6	0 06	0 046	*		*			
37 Contents (bile)*	47	36	*		47 *	36	45	34	0 47	0 36	0 85	1	0 23	0 17	1 04	1 02
38 GI tract*	1000	790	*		1000 *	790	770	600	7 9	6 2	50	55	120	110	1 05	1 03
39 Contents (food plus digestive flui	900	690	*		900 *	690	*		*		*		*			
40 Esophagus	30	28			30	28	23	17	0 27	0 2					1 05	1 03
41 Stomach	120	95	3 8	3	116	92	86	68	0 94	0 75	7 5	8	16	13	1 06	1 04
42 Contents	230	170			230	170										
43 Intestine	850	660			850	660	670	520	6 7	5 2	54	61	100	80	1 05	1 03
44 Contents	670	520			670	520										
45 Small intestine	540	420			540	420	420	330	4 2	3 3	34	40	69	53	1 05	1 03
46 Contents	330	260			330	260										
47 Duodenum	40	30			40	30	31	23	0 32	0 24	2 5	2 9	5 2	3 9	1 06	1 04
48 Jejunum	240	190			240	190	190	150	1 8	1 5	15	18	31	24	1 05	1 03
49 Ileum	260	200			260	200	200	150	2	1 6	17	19	33	25	1 05	1 03
50 Large intestine	310	240			310	240	250	190	2 5	1 9	20	22	34	27	1 05	1 03
51 Contents	340	260			340	260										
52 Upper large intestine	170	130			170	130	130	100	1 4	1	11	12	22	17	1 05	1 03
53 Contents	210	160			210	160										
54 Ascending colon and cecum	75	56			75	56	59	44	0 6	0 45	4 7	5 5	10	7 5	1 05	1 03
55 Transverse colon	95	75			95	75	75	59	0 76	0 6	5 9	6	12	9 5	1 05	1 03
56 Lower large intestine	140	110			140	110	110	89	1 1	0 9	9	10	12	9 7	1 05	1 03
57 Contents	130	100			130	100										
58 Descending colon	74	56			74	56	58	44	0 59	0 44	5	6	3 1	2 4	1 05	1 03
59 Sigmoid colon	47	38			47	38	38	30	0 38	0 3	2 9	2 9	6 1	4 9	1 05	1 03
60 Rectum	19	19			19	19	15	15	0 15	0 15	1 1	1 1	2 5	2 5	1 05	1 03
61 Hair*	23	70	*		23 *	70	1 9	5 9	0 12	0 36	0 55	1 7	20	61	1 31	1 29
^62 Heart*	290	240	69	57	217 *	180	160	130	2 9	2 4	21	24	35	32	1 04	1 02
63 Contents (av)*	380	290	360	270	*		310	230	3 6	3 7	1 9	3 5	69	52	1 07	1 05
^64 Kidneys (2)*	250	230	38	34	210 *	194	150	140	2 4	2 2	23	26	35	31	1 06	1 04
65 Larynx*	25	20	*		25 *	20	17	13	0 75	0 6	*		*		1 09	1 07
^66 Liver*	1400	1200	150	140	1241 *	1052	860	780	17	15	140	190	190	170		
^67 Lung*	930	710	570	270	326 *	424	730	560	9 5	7 3	8 7	9 5	170	130	1 06	1 04
															deflated	
															0 26	0 26
															inflated	
68 Parenchyma (includes bronchial tree plus capillary blood)	430	330	77	70	348	256	330	250	4 7	3 6	5 3	6	76	58	1 01	0 99
^69 Blood (arterial and venous)	500	380	470	360			400	310	4 8	3 7	3 3	3 5	91	68	1 07	1 05
70 Bronchial tree	24	18			24	18										

Table V (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
71 Lymphocytes	1200	910			1200	910										
72 Lymphatic tissue	540	410			540	410										
73 Lymph nodes (dissectible)*	210	160	2 9	2 6	207 *	157	*		*		*		*			
74 Miscellaneous*	2500	4400	*		2100 *	3900	*		*		*		*			
75 Solid soft tissue	2200	4180			2200	4200										
76 Fluid (synovial, pleural, etc)	300	250			300	250	230	170								
^77 Muscle (skeletal)*	23000	20000	400	360	22576 *	19618	18000	16000	300	250	300	600	3500	2900	1 05	1 03
78 Nails (20)*	3	3	*		3 *	3	0 2	0 2	*		*		*		1 31	1 29
79 Pancreas*	100	89	12	11	87 *	77	60	53	1 9	1 7	12	13	14	12	1 06	1 04
80 Parathyroid (4)*	0 12	0 16	*		0 1 *	0 2	*		*		*		*		1 06	1 04
81 Pineal*	0 18	0 16	*		0 2 *	0 2	*		*		*		*		1 08	1 06
^82 Pituitary*	0 53	0 61	0 06	0 07	0 47 *	0 54	0 35	0 4	0 01	0 01	0 08	0 1	0 04	0 04		
83 Prostate*	11 *		*		11 *		*		*		*		*		1 06	1 04
83a Contents*	3 6 *		*		3 6 *		*		*		*		*			
84 Salivary glands (6)*	77	59	5 7	5 2	71 *	53	58	45	*		*		*		1 06	1 04
85 Parotid (2)	45	35	3 8	3	41	32									1 06	1 04
86 Submaxillary (2)	23	17	2	1 5	21	15									1 06	1 04
87 Sublingual (2)	9	6 8	0 59	0 44	8 4	6 3									1 06	1 04
^88 Skeleton*	7300	5700	200	180	7088 *	5509	2300	1700	2300	1800	1200	1100	1400	1100	1 41	1 39
^89 Bone	4000	3000	140	130	3852	2862	670	500	2200	1700	35	41	1000	750	2 22	2 18
90 Cortical	3200	2400			3200	2400	480	360	1800	1400	27	32	800	600	1 87	1 83
91 Trabecular	800	600			800	600	190	140	400	300	8	9	200	150	1 09	1 07
92 Red marrow	900	750	41	37	857	711	360	270	5 3	4	360	400	180	140	1 04	1 02
93 Yellow marrow	1000	900	13	12	986	887	200	180	2 2	1 7	750	690	44	34	0 99	0 97
94 Cartilage	840	640			840	640	650	490	34	26	10	12	130	99	1 11	1 09
95 Periarticular tissue (skeletal)	600	450			600	450	390	300	25	19	7 5	10	94	71	1 11	1 09
96 Skin*	2200	1700	43	39	2154 *	1659	1600	1400	16	13	170	190	630	470	1 11	1 09
97 Epidermis	100	76			100	76									1 16	1 14
98 Dermis	2100	1600			2100	1600									1 13	1 11
^99 Hypodermis (see adipose tissue)	4900	4600			4900	4600									0 98	0 96
100 Spleen*	120	110	57	54	60 *	53	43	41	0 9	0 9	2 1	2 5	15	14	1 07	1 05
101 Teeth (32)*	45	34	*		45 *	34	4 4	3 4	32	25	*		6 8	6 2	2 12	2 08
102 Enamel	10	7			10	7	0 25	0 19	8 6	6 6			0 11	0 082		
103 Dentin	34	26			34	26	3 5	2 7	23	18			0 14	0 11		
104 Pulp	1	1			1	1	0 7	0 53	0 1	0 076	0 01	0 0076	0 6	0 46		
105 Testes (2)*	33 *		2 5 *		30 *		23 *		0 3 *		2 9 *		4 6 *		1 05	1 03

Table V (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^106 Thymus*	37	32	8 1	7	28 *	25	17	15	0 2	0 2	7 8	8 5	3 7	2 5	1 04	1 02
^107 Thyroid*	16	15	2 1	2	14 *	13	9 2	8 9	0 2	0 1	1 8	2 2	2 2	2	1 06	1 04
108 Tongue*	67	51	*		67 *	51	42	32	0 66	0 5	10	12	10	7 6		
109 Tonsils (2 palatine)*	4	3	*		4 *	3	3	2 3	*		*		*			
110 Trachea*	8	6	*		8 *	6	4 4	3 4	0 12	0 094	*		*		1 09	1 07
111 Ureters (2)*	13	14	*		13 *	14	8 9	9 6	*		*		*			
112 Urethra*	8	5	*		8 *	5	6	3 8	*		*		*			
113 Urinary bladder*	38	30	*		38 *	30	25	19	0 3	0 24	*		*			
114 Contents (urine)*	96	78	*		96 *	78	89	72	1	0 84	*		5 8	4 7	1 03	1 01
^115 Breast*	20	270	*		20 *	270	6 4	190	0 08	2 4	1 2	36	0 32	9 6		
^116 Ovary*		9 8	*		*	10	*		*		*		*			
^117 Penis*	42 *		*		42 *		30 *		*		*		*		1 05	1 03
^118 Uterus*		63	*		*	63	*		*		*		*			
119 Uterine tube*		8 9	*		*	9	*		*		*		*			
120 Vagina*		22	*		*	22	*		*		*		*			
Total body	54000	49000	4100	3000	50000	46000	36000	31000	2900	2400	7500	9500	7300	6900		
Total of asterisked quantities	54000	49000	4400	3600	49600	45000	31000	27000	2800	2200	8100	8300	7600	6300		

(Asterisked quantities make up the totality of Reference Asian Man)

RAMM Reference Asian Man, Male RAMF Reference Asian Man, Female by G Tanaka

Table VI. Physical properties, contents of blood, water, mineral, lipid and Protein of all organs and tissues for Reference Asian Man male(RAMM) and female(RAMF): adult

[NIRS-M-85,95,115, ICRP23]

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^1 Total body	60000	51000	4500	3600	55230	47184	37000	29000	3300	2500	10000	13000	8900	6800	1 06	1 04
1a Total soft tissue	52000	45000			52000	45000	34000	27000	340	290	9700	11000	8000	6300		
1b Total hard tissue	8400	6400			8400	6400										
2 Adipose tissue	11000	13000	150	120	10841	12873	1900	1700	22	16	8600	11000	540	410	0 92	0 90
3 Subcutaneous (hypodermis)*	5500	7000	75	65	5421 *	6931	910	880	11	8	4300	5900	280	210	0 97	0 95
4 Other separable*	3500	4500	55	45	3442 *	4452	620	520	6 6	5	2700	3800	170	130	0 92	0 90
5 Interstitial	700	530			700	530	110	90	1 4	1	550	410	35	27	0 92	0 90
6 Yellow marrow (skeleton)	1300	990	20	10	1279	979	250	160	2 6	1 9	1000	790	52	40	0 98	0 96
^7 Adrenals (2)*	14	13	1 1	1	13 *	12	8 9	8	0 1	0 1	3	3	2 4	1 9	1 02	1 00
8 Aorta*	90	68	*		90 *	68	63	48	1 3	0 98	1 1	1 4	24	18		
9 Contents*	170	130	150	120	*		140	110	1 7	1 3	0 9	1 1	27	18	1 06	1 04
^10 Blood	4800	3800	4500	3600			3900	3100	46	37	32	35	870	680	1 06	1 04
11 Plasma	2700	2100					2500	1900	23	19	17	21	160	130	1 03	1 01
12 Erythrocytes	2100	1700					1400	1100	23	18	15	14	710	550	1 09	1 07
13 Blood vessels*	180	140	*		180 *	140	140	110	1 1	0 86			39	29	d	d
14 Contents (except aorta and pulmo	2100	1600	*		*		1700	1300	20	16	14	15	380	290	1 06	1 04
^15 Body fat	10000	13000			10000	13000					10000	13000			0 92	0 90
16 Essential	1200	1000			1200	1000					1200	1000			0 92	0 90
17 Nonessential	8800	12000			8800	12000					8800	12000			0 92	0 90
^18 Body water	37000	29000			37000	29000	37000	29000							1 00	0 98
19 Extracellular	16000	12500			16000	12500	16000	12500							1 00	0 98
20 Intracellular	21000	16500			21000	16500	21000	16500							1 00	0 98
21 Cartilage (skeleton)	900	700			900	700	700	530	37	29	11	14	140	110	1 10	1 08
22 Connective tissue	2900	2200			2900	2200	1800	1400	120	91	29	37	1100	810	1 20	1 18
23 Tendons and fascia	1200	910			1200	910	750	570	49	37	12	15	450	340	1 20	1 18
24 Periarticular tissue	1300	990			1300	990	820	620	54	41	13	17	490	370	1 20	1 18
25 Other connective tissue	400	300			400	300	260	200	17	13	4	5 1	140	100	1 20	1 18
26 Separable connective tissue*	1400	1100	*		1400 *	1100	900	720	58	46	16	20	430	320	1 20	1 18
^27 Central nervous system*	1500	1400	25	23	1474 *	1376	1200	870	22	16	160	200	120	87		
^28 Brain	1470	1320			1470	1320	1100	850	22	16	160	200	110	85	1 03	1 01
29 Cerebrum	1280	1130			1280	1130	980	730	19	14	140	180	98	73		
30 Cerebellum	160	160			160	160	130	98	2 5	1 8	14	18	13	10		
31 Brain stem	30	30			30	30	23	18	0 45	0 35	3 3	4 2	2 4	1 8	1 04	1 02
32 Spinal cord	30	30			30	30	24	20	0 4	0 33	3	3 8	2 6	2 1	1 03	1 01
33 Contents (cerebrospinal fluid)*	110	83	*		110 *	83	110	83	0 7	0 53	*		0 03	0 02	1 01	0 99
^34 Eyes (2)*	15	12	*		15 *	12					*		*		1 03	1 01
^35 Lenses (2)	0 4	0 3			0 4	0 3	0 27	0 2	0 0016	0 0016	0 008	0 01	0 14	0 1	1 10	1 08

Table VI (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
36 Gall bladder*	8	6	*		8 *	6	7 9	6	0 06	0 05	*		*			
37 Contents (bile)*	50	38	*		50 *	38	48	36	0 5	0 38	0 9	1 1	0 24	0 18	1 03	1 01
38 GI tract*	1100	850	*		1100 *	850	850	620	8 7	6 7	67	85	130	100	1 04	1 02
39 Contents (food plus digestive flui	950	730	*		950 *	730	*		*		*		*			
40 Esophagus	40	30			40	30	30	23	0 36	0 27					1 04	1 02
41 Stomach	140	110	4 4	3 5	135	106	100	79	1 1	0 86	8 7	11	19	15	1 05	1 03
42 Contents	240	180			240	180										
43 Intestine	920	710			920	710	720	520	7 2	5 6	58	74	110	85	1 04	1 02
44 Contents	710	550			710	550										
45 Small intestine	590	450			590	450	460	340	4 6	3 5	37	47	76	57	1 04	1 02
46 Contents	350	270			350	270										
47 Duodenum	50	40			50	40	39	31	0 4	0 32	3 1	3 9	6 5	5	1 05	1 03
48 Jejunum	260	200			260	200	200	150	2	1 5	16	20	33	25	1 04	1 02
49 Ileum	280	210			280	210	220	160	2 2	1 7	18	23	36	27	1 04	1 02
50 Large intestine	330	260			330	260	260	170	2 6	2 1	21	27	37	28	1 04	1 02
51 Contents	360	280			360	280										
52 Upper large intestine	180	140			180	140	140	79	1 4	1 1	11	14	24	18	1 04	1 02
53 Contents	220	170			220	170										
54 Ascending colon and cecum	80	60			80	60	63	47	0 64	0 48	5	6 4	11	8	1 04	1 02
55 Transverse colon	100	80			100	80	79	32	0 8	0 64	6 2	7 9	13	10	1 04	1 02
56 Lower large intestine	150	120			150	120	120	95	1 2	0 96	9 7	12	13	10	1 04	1 02
57 Contents	140	110			140	110										
58 Descending colon	80	60			80	60	63	47	0 64	0 48	5 4	6 9	3 4	2 5	1 04	1 02
59 Sigmoid colon	50	40			50	40	40	32	0 4	0 32	3 1	3 9	6 5	5 2	1 04	1 02
60 Rectum	20	20			20	20	16	16	0 16	0 16	1 2	1 5	2 6	2 6	1 04	1 02
61 Hair*	25	75	*		25 *	75	2 1	6	0 13	0 39	0 6	0 76	22	66	1 30	1 28
^62 Heart*	380	320	89	76	286 *	239	200	170	3 4	2 9	26	24	54	44	1 03	1 01
63 Contents (av)*	400	300	380	290	*		320	240	3 8	3 9	2	3 7	73	54	1 06	1 04
^64 Kidneys (2)*	320	280	49	42	268 *	235	190	170	2 8	2 4	30	29	51	42	1 05	1 03
65 Larynx*	27	20	*		27 *	20	18	13	0 81	0 6	*		*		1 08	1 06
^66 Liver*	1600	1400	180	150	1409 *	1241	980	840	18	15	160	150	260	210		
^67 Lung*	1200	910	710	540	447 *	338	940	720	12	9 3	11	13	210	160	1 05	1 05
															deflated	
															0 26	0 26
															inflated	
68 Parenchyma (includes bronchial tree plus capillary blood)	500	380	90	68	405	308	380	290	5 5	4 1	6 2	7 9	88	67	1 00	0 98
^69 Blood (arterial and venous)	700	530	660	500			560	430	6 7	5 2	4 7	4 9	130	95	1 06	1 04
70 Bronchial tree	26	20			26	20										

Table VI (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
71 Lymphocytes	1300	990			1300	990										
72 Lymphatic tissue	600	450			600	450										
73 Lymph nodes (dissectible)*	220	170	3	2 2	217 *	168	*		*		*		*			
74 Miscellaneous*	2500	790	*		2500 *	790	1900	550	170	60	220	230	210	40		
75 Solid soft tissue	2100	540			2100	540										
76 Fluid (synovial, pleural, etc)	400	250			400	250	300	250								
^77 Muscle (skeletal)*	25000	20000	410	360	24565 *	19618	20000	15000	280	280	420	620	4300	3800	1 04	1 02
78 Nails (20)*	3	2 3	*		3 0 *	2 3	0 2	0 15	*		*		*		1 30	1 28
79 Pancreas*	130	110	16	13	113 *	96	80	67	2 4	2	17	15	19	15	1 05	1 03
80 Parathyroid (4)*	0 12	0 14	*		0 1 *	0 1	*		*		*		*		1 05	1 03
81 Pineal*	0 18	0 14	*		0 2 *	0 1	*		*		*		*		1 07	1 05
^82 Pituitary*	0 54	0 64	0 06	0 07	0 48 *	0 57	0 37	0 41	0 01	0 01	0 09	0 11	0 05	0 04		
83 Prostate*	12 *		*		12 *		9 4 *		0 2 *		0 15 *		1 7 *		1 05	1 03
83a Contents*	4 *		*		4 *		2 7 *		*		*		0 15 *			
84 Salivary glands (6)*	82	62	6 1	5	76 *	57	62	47	*		*		*		1 05	1 03
85 Parotid (2)	48	36	4 1	3 5	44	32									1 05	1 03
86 Submaxillary (2)	24	18	2 1	1 8	22	16									1 05	1 03
87 Sublingual (2)	10	7 6	0 65	0 6	9 3	7 0									1 05	1 03
^88 Skeleton*	8400	6400	210	180	8177 *	6209	2700	2000	2500	1900	1500	1200	1800	1300	1 40	1 37
^89 Bone	4500	3400	160	140	4330	3252	810	610	2500	1800	40	52	1200	900	2 20	2 16
90 Cortical	3600	2700			3600	2700	590	440	2000	1500	30	40	980	720	1 85	1 82
91 Trabecular	900	700			900	700	220	170	450	340	10	12	220	180	1 08	1 06
92 Red marrow	1000	780	45	34	950	744	400	280	5 9	4	400	380	200	120	1 03	1 01
93 Yellow marrow	1300	990	15	11	1300	978	250	160	2 6	1 9	1000	790	52	40	0 98	0 96
94 Cartilage	900	700			900	700	700	530	37	29	11	14	140	110	1 10	1 08
95 Periarticular tissue (skeletal)	700	530			700	530	500	380	33	28	8 8	11	160	110	1 10	1 08
96 Skin*	2400	1800	47	40	2400 *	1758	*		*		*		*		1 10	1 08
97 Epidermis	100	76			100	76									1 15	1 13
98 Dermis	2300	1700			2300	1700									1 12	1 10
^99 Hypodermis (see adipose tissue)	5500	7000			5500	7000									0 97	0 95
100 Spleen*	140	120	65	60	66 *	56	49	45	1	0 9	2 2	2 3	17	16	1 06	1 04
101 Teeth (32)*	45	34	*		45 *	34	4 7	3 5	34	25	*		0 87	0 66	2 10	2 06
102 Enamel	10	7 3			10	7	0 28	0 2	9 6	7 3			0 12	0 09		
103 Dentin	34	26			34	26	3 7	2 8	24	18			0 15	0 11		
104 Pulp	1	0 7			1 0	0 7	0 7	0 5	0 1	0 08	0 01	0 01	0 6	0 46		
105 Testes (2)*	37 *		2 8 *		34 *		25 *		0 4 *		3 2 *		5 5 *		1 04	

Table VI (Cont.)

1 Organ, tissue, or component	2 Weight in situ (g)		3 Total blood (ml)		4 Organs without Free Blood (g)		5 Water (g)		6 Mineral (g)		7 Lipid (g)		8 Protein (g)		9 Specific gravity	
	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	RAMM	RAMF	AM	RAMF
^106 Thymus*	30	29	6 6	6 3	23 *	22	13	12	0 1	0 1	6 4	6 7	3 8	3	1 03	1 01
^107 Thyroid*	19	17	2 6	2 3	16 *	15	11	10	0 2	0 2	2 2	2 2	2 8	2 3	1 05	1 03
108 Tongue*	67	51	*		67 *	51	45	34	0 7	0 53	11	14	11	8 4		
109 Tonsils (2 palatine)*	4	3	*		4 *	3	3	2 3	*		*		*			
110 Trachea*	9	6 8	*		9 *	6 8	5	3 8	0 14	0 11	*		*		1 08	1 06
111 Ureters (2)*	14	15	*		14 *	15	9 6	10	*		*		*			
112 Urethra*	9	6	*		9 *	6	6 8	4	*		*		*			
113 Urinary bladder*	40	30	*		40 *	30	26	19	0 32	0 24	*		*			
114 Contents (urine)*	100	85	*		100 *	85	93	79	1 1	0 94	*		6 2	5 3	1 02	1 00
^115 Breast*	22	300	*		22 *	300	15	200	0 1	3	3	50	4	47		1 02
^116 Ovary*	d	11	*		*	11	*		*		*		*			1 02
^117 Penis*	47 *		15 *		31 *		38 *		0 6 *		0 4 *		8 *		1 04	
^118 Uterus*	d	70		30	*	38		57		0 89		0 6		12		1 04
119 Uterine tube*	d	10		5	*	5		8 1		0 13		0 085		1 7		1 04
120 Vagina*	d	25		10	*	14		20		0 32		0 21		4 3		1 04
Total body	60000	51000	4500	3600	55000	47000	37000	29000	3300	2500	10000	13000	8900	6800		
Total of asterisked quantities	60000	51000	4500	3600	55000	47000	36000	27000	3200	2400	9800	13000	9200	7400		

(Asterisked quantities make up the totality of Reference Asian Man)

RAMM Reference Asian Man, Male RAMF Reference Asian Man, Female by G Tanaka

REFERENCES

[1] Working Material, Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man: Research Co-ordination Meeting within the IAEA/RCA Co-ordinated Research Programme held in Bombay, 8-12 April 1991.

[2] Report, Project Formulation Meeting, Co-ordinated Research Project on Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, held in Mito City, Japan, 17-21 October 1998.

[3] G. Tanaka, Reference Japanese Vol. 1, NIRS-M-85, National Institute of Radiological Sciences, Chiba, Japan (1992).

[4] J. Wang et al., Reference Values of Body Height and Weight in China, Chin. J. Radiol. Med. Prot. 13 (1): 3 (1993).

[5] H. S. Dang, D. D. Jaiswal, M. Parameswaran and S. Krishnamony, Physical, Anatomical and Metabolic Data for Reference Indian Man - a Proposal, BARC/1994/E/043, Bhabha Atomic Research Centre, Bombay, India (1994).

[6] G. Tanaka, Anatomical and Physical Characteristics for Asian Reference Man - a Proposal, NIRS-M-95, National Institute of Radiological Sciences, Nakaminato, Japan (1993).

[7] G. Tanaka and H. Kawamura, Anatomical and Physical Characteristics for Asian Reference Man - Male and Female of Different Ages: Tanaka Model, NIRS-M-115, National Institute of Radiological Sciences, Hitachinaka, Japan (1996).

4. CONCLUSIONS

In reviewing the conclusions presented here, it is important to emphasize that the quantity and quality assurance for the individual national results presented in this report are highly dependent on the situation in each country, including funding and support provided in addition to that provided by the IAEA/RCA. However, the results that have been compiled can be considered a valuable data base for the purpose of national and international decision radiation protection and as a basis for setting research priorities.

As a general conclusion, considering the ranges of mean national values obtained through this Coordinated Research Programme, single reference values for certain parameters may not be representative for certain countries. Each country must review local, regional and national statistics to determine what is appropriate for its situation. It may be justified to undertake a specific research programme to obtain specific national reference values for population variables related to radiation protection. It should be noted that, with reference to ***Worldwide Variation in Human Growth***, by P.B. Eveleth and J.M. Tanner, Cambridge University Press (1990), the ranges in anthropomorphic parameters reported in this CRP are generally wider than the equivalent ranges for European country populations.

The data compiled under this CRP do not appear to sufficiently different from the values which served as the basis for the recommendations presented in the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (Safety Series No. 115) to warrant deviation from those recommendations for normal or routine internal dosimetry purposes. However, specific situations could occur in which use of the population specific data presented in this report may be appropriate for decision making and dosimetry purposes.

I. Physical Measurements

A. Linear parameters

1. The linear measurements reported in the (height, sitting height, etc.) have a ranges of values for the nine countries providing results. The maximum/minimum body height for adult males, for example, is 1.044 and the equivalent female value is 1.048.

2. The mid-range of national values for linear measurements are generally significantly less than the equivalent values recommended by the ICRP. For example, the male height (167 cm) for the 9 countries is 5.1% less than the equivalent value of 176 cm to be recommended in the revision of Report 23 and published in ICRP Report 66. The minimum national mean (163.4 cm) is 7.2% less than the new ICRP value.

B. Body mass

1. The reported body mass ranges are significantly wider than those for the linear measurements. The maximum/minimum for adult males, for example, is 1.24 and the equivalent female value is 1.23.

II. Organ Masses

1. Accurate measurement of organ masses depends on strict adherence to prescribed protocol. Factors such as presence or absence of blood, failure to remove extraneous tissue, delay in post-mortem measurement, etc can adversely effect the accuracy of the measurement.

2. The relationship between organ mass ranges and the ICRP recommended values is not consistent, but the mean masses tend to be less than the ICRP values.

III. Dietary Results

1. The majority of mean values for nutritional characteristics in reported diets are generally significantly below equivalent values recently reported by the WHO.

2. The relative contribution of cereals (primarily rice) and vegetables to the diets reported for this CRP is significantly higher than for western population diets.

3. Animal proteins, oils and fats are substantially less than those reported for western diets.

4. The mean values dietary contents of minor and trace elements are generally less than results reported by the WHO.

IV. Physiological Function

1. Measurement of pulmonary function and water balance parameters for large numbers of people is an difficult and expensive task. Therefore, the number of results presented in this report are generally very limited, and the mean values can not be considered definitive measurements for the Asian population.

2. Values for pulmonary function parameters depend on a number of factors, including activity level, ambient temperature and humidity. However, mean values **tend** to be lower than equivalent values presented in ICRP Report 23.

3. Measurement of water balance is made difficult by the multitude of mechanisms for elimination (urine, feces, sweat, and breath). Therefore, the number of results presented were severely limited. However, the particular values and pathways for intake and elimination are also highly dependent on ambient and environmental conditions (temperature, humidity and level of effort). This is particularly important in the tropical conditions that are prevalent in many Asian countries.

5. RECOMMENDATIONS

1. The database on anthropomorphic parameters (height, weight, sitting height, etc) compiled in this CRP should be used, where appropriate, in applications such as fabrication of phantoms for internal dosimetry.

2. A specific regional programme aimed to provide guidance to those responsible for internal dosimetry programmes would be very valuable. This might take the form of a workshop on design, construction and use of phantoms for calibration of whole body and lung counting facilities. In addition, establishment of a network of regional experts to provide advise on phantom construction and whole body/organ counter calibration is very important.

3. Continuation of a regional programme for measurement of organ masses may not be practical for financial reasons. However, individual countries are encouraged to initiate such measurement programmes when it is appropriate to their needs. Without more accurate or country specific data, use of the existing database together with the detailed model developed by the Japanese National Institute of Radiological Sciences and application of the associated scaling rules based on body height and weight may provide an acceptable alternative for some organs. However, they should be applied only to population groups and are not recommended for application to individual adults.

4. A suitable alternative to development of mathematical human models may be application of a system of scaling developed by the Oak Ridge National Laboratory based on body height and organ weight to determine Specific Absorbed Fraction (SAF) values which can be used, together with ICRP Report 30 methodology, to conduct the necessary dose calculations.

5. Additional data on specific elements related to uptake of important radionuclides in national diets and selected organs from people within the RCA region is needed for internal dose assessment in the RCA countries. Continued research, with emphasis on quality assurance, should be undertaken to obtain this information for each RCA country. This programme should be formulated using methodology and protocols already established in other IAEA nutrition studies.

6. Additional regional studies on physiological parameters may not be cost effective. However, scaling rules based on body height and weight have been identified in this study and by the ICRP which can be used to predict key pulmonary function parameters.

Annex I

PROTOCOLS DEVELOPED DURING THE PROJECT FORMULATION MEETING (Mito City, Japan, 17–21 October, 1988)

1. Measurements of physique

Height of the total body or stature, and weight of the total body along with sitting height and chest girth may be obtained through literature survey or by conducting measurement by using ordinary techniques of international standards (see ref. for example):

	Unit	Significant digit
Height of the total body	cm	three (<100 cm) four (≥100 cm)
Weight of the total body	kg	three
Sitting height	cm	three
Chest girth	cm	three

The following measurements may not be found in many official statistics data, but will provide necessary information for phantoms:

Height of head and neck (from clavicle to top of head)
Head circumference
Head width
Neck circumference

Other measurements, such as dimensions of breast, the length and circumference of the arm, the length of the leg, etc. will also be of useful information.

2. Mass of internal organs

The following criteria are proposed for obtaining normal values of mass of internal organs in the literature survey and actual measurement:

- Subjects to be studied are who died of sudden deaths.
- Autopsy should be carried out by qualified medical doctors within 24 hours after death (in case of the temperature zone) in such a way that in situ mass of organs might be obtained.
- Data should be obtained from those who are found at autopsy to have been healthy and normal shortly before death.
- Data should be obtained from those who do not show any of the following pathological changes in any organ(s): inflammation, anaemia, atrophy, regressive change, fatty degeneration, neoplasm, or tumor, all of which tend to cause a change in the normal weight of organs.

Organs to be studied (an example)

Adrenal glands	Pancreas
Brain	Pituitary gland
Heart	Spleen
Kidney	Testes
Liver	Thymus
Lungs	Thyroid gland

- Nutritional condition as well as the height and weight of the body may also be observed.

3. Important points for food consumption survey

- To make clear total population and numbers of families surveyed.
- To make clear criteria of the family selection.
- It is required to know the weight of raw materials (but edible part only) of the dishes.
- Seasonal variations must be taken into consideration. This means survey should cover every season.
- It is necessary to use the same criteria for classification of food.
- Inter-regional variations in food consumption and also between the consumption pattern of urban and rural pattern should be included in study if required.
- Age dependent data (average food consumption data) should be provided, if necessary.

Some other important points for the determination of daily intake of principal nutrients and trace elements.

- To make clear as to the food sampling method: a) duplicate meal sampling method, or b) market basket sampling method
- To make clear as to the treatment of food: a) cooked b) uncooked

Annex II

DESCRIPTION OF SRT05Z
SUMMARY STATISTICS SOFTWARE

Background

For unusually large data sets, (> 100,000 one hundred thousand cases) possibly with a few variables, even the most sophisticated applications, such as EXCEL from Microsoft, on today's high powered microcomputers cannot handle the computation of simple summary statistics. Yet microcomputers with modest hardware configuration and performance parameters could easily menage the task. The Summary Statistics Software, a low tech, no frills computer program, has been designed to run on a minimum configuration IBM compatible PC.

The limited central memory (RAM) size is the main difficulty: large data sets cannot fit into the RAM. Most applications running under DOS, however, require just that. The natural solution to the problem is a software design which builds on hard disk based data manipulation. Let us briefly review the key algorithmic problem of such a code.

If one is only interested in calculating recursively computable summary statistic measures then such a task is very simple indeed. The recursively computable summary statistics require at any one time only one value of the data vector and the result of the latest recursion. For instance the following formulas calculate the mean $\overline{x_N}$ and variance VAR(N) of a data vector {x(1), ..., x(N)}.

$$\overline{x_{i+1}} = \frac{i}{i+1}\overline{x_i} + \frac{1}{i+1}x_{i+1}$$

$$VAR_{i+1} = \frac{i-1}{i}VAR_i + \frac{i+1}{i^2}(x_{i+1} - \overline{x_{i+1}})^2$$

for i = 0, 1, ..., N-1 with $\overline{x_0}=0$ and $VAR_0=0$.

In these cases a program can read the data in from disk, in chunks that the central memory can handle, and by applying the recursive relations the final answer will be supplied when the last data point is input.

Other summary statistics such as median, or all percentiles for that matter, do not yield such recursive relationships because they are closely related to the ordering of the data vector, a typical non-recursive algorithmic problem. Our program, in pursuit of finding *exact* percentiles of large data sets, employs a three pass approach. That is, the data set stored on hard disk, will be read three times before the program run concludes. There are clever methods available for one pass computations, but these, as far as I could tell, are either approximate or the algorithm that they use might fail under certain, as they claim unusual circumstances.

Program description

Language

The program has been written in Microsoft Quick Basic version 4.5. It runs as a stand alone .EXE executable file.

Hardware and operating system requirements

IBM compatible XT or later models are required with data stored on hard disk. Although the program attempts to print the final results, the printer is optional since the final output file is stored as a *.TXT file in any case. In general there is no easy solution for good printing. Printing in DOS environment depends on certain factors such configuration and printer drivers, as well as the special setting of the printer. We had the best result with an HP LaserJet Series II printer. A newer model HP 4 for instance produces a less than satisfactory hard copy.

The operating system should be DOS 3.2 or higher.

Algorithm

As mentioned above the program employs a three pass approach on the data. In the first pass it computes the recursively computable summary statistics measures: average, standard deviation, minimum, maximum values. Based on these the second pass determines a partition of the data and builds a frequency table accordingly. In addition the skewness and kurtosis measures are also computed. The third pass on the data stores in RAM only those data points which are in the critical intervals of the partition, i.e. in which the selected percentiles fall. These are then sorted and the exact percentiles can be counted down within the intervals.

Program user's guide

Input

The input file has to be of ASCII type with *.DAT extension. The input data set is organized into variables (columns) and cases (rows). The variable names are in the first record (row). There is no limitation on the number of variables (columns) and cases (rows) in the input data set.

Any delimiter can be used in the input and it should be supplied when prompted for. Missing data entries are allowed, in this case, however, one cannot use blanks (or tabs) for field delimiter for obvious reasons.

The output file name has to be supplied before the computation starts. Default file name is provided.

In one run the summary statistics will be computed for any, but only one variable.

Output

The computer screen provides information about the status of the run of the program. This includes among others the display of the latest summary statistics calculated. The final results are stored on a user specified file and at the same time printing is attempted when afforded. The output file is in ASCII format, even the histogram it provides is rendered in character graphics.

The set of summary statistics calculated by the program can be seen on the attached sample runs.

Running the program

Running the program is self explanatory. It is a single file SRT05Z.EXE. It can be invoked either from floppy disk or hard disk. Typing SRT05Z starts execution. Answer the dialog questions (as usual one has to hit the ENTER key after an answer field is set).

BIBLIOGRAPHY

1986 Statistical Yearbook, Statistical Press (1987) [In Chinese].

ACADEMIE DES SCIENCES DE L'USRR - Institut national d'informations des sciences et technique - Revue informatique des sciences et technique - Serie d'anthzopologie - Tome 3 Taille et development des enfants et adolescents (en langue Russe) - Moscow, 187 pp (1985).

ACHAR, B.T., YANKAUER, A, "Studies on the birth weight of South Indian infants". Indian J. Child Health. 11: 157 (1961).

AHMED, K., AND HASSAN, N., Report on Nutrition Survey of Rural Bangladesh 1981-1982, Institute of Nutrition and Food Science, University of Dhaka.

AIMI, S., YASOSHIMA, S., SUGAI, M., SATO, B., SAKAI, T. AND NAKAJIMA, Y., "Studies on the weight and size of the internal organs of normal Japanese". Acta Path. Jap., 2, 173 (1952).

ALI, M., BISWAS, S.K., AKHTER, S., KHAN, A.H., "Multielement Analysis of Water Residue: A PIXE Measurement", Fresenius Z. Anal, Chem. 322: 755-760 (1985).

ALI, M., ISLAM, A., KAR, S., BISWAS, S.K., HADI, D.A., KHAN, A.H., "The status of trace and minor elements in pulses: A PIXE measurement", Journal of Radioanalytical and Nuclear Chemistry, Articles 97/1, 113-122 (1986).

ALL-CHINA JOINT GROUP ON THE WEIGHT OF INTERNAL ORGANS, A Statistical Analysis of the Normal Weight of Internal Organs of the Chinese, Chinese Journal of Pathology 17(2): 111 (1988) [In Chinese].

ALTMAN P.L. GIBSON J.F., WANG CH. C., Handbook of Respiration. National Acad. of Sciences USA. W.B. Sciences company, Philadelphia and London (1958).

ANDA, M.O. et. al., Ang Pilipinas Noon at Ngayon, National Book Store, p.60 (1990).

AVADHANI AND SHETTY. "Total body water in adult Indian subjects". Indian J. Med. Res. 84: 217 (1986).

BALAVADY, B., Indian Council of Medical Research (ICMR), Special Report Series No.43: 1 (1963).

BANERJEE, S., SEN, T., "Studies in Energy Metabolism". J. Appl. Physiology. 12: 29 (1958).

BANIK DATTA, N.D., "Semilongitudinal growth evaluation of children from birth up to 14 years in different socio-economic groups". Indian Pediatrics, 19: 353 (1982).

BEIJING PAEDIATRIC RESEARCH INSTITUTE, Survey of Body Growth of Children and Youngsters in Nine Cities, Chinese Medical Journal 57: 720 (1977) [In Chinese].

BEIJING PAEDIATRIC RESEARCH INSTITUTE, PATHOLOGY AND OTHER DIVISIONS, 1980 Cases of Measurement of the Weight and Size of Children's Internal Organs, Chinese Journal of Pathology 13(1): 59 (1984) [In Chinese].

BEIJING PAEDIATRIC RESEARCH INSTITUTE, Long-term Trends (1975-1985) in the Body Growth of 7-18 Year Olds in 9 Chinese Cities:Compilation of Survey Data on the Body Growth of Children and Youngsters in Nine Chinese Cities (1985) [In Chinese].

BEIJING PAEDIATRIC RESEARCH INSTITUTE, A Study of the Body Growth of Children Below Seven Years of Age in the Outskirts of Nine Cities in 1985, Chinese Medical Journal, 67: 423 (1987) [In Chinese].

BELL R.F., GILLILAND, J.C., "Radiological Health and Safety in Mining, Milling Nuclear Materials". 2: 399 (1964).

BHARGAVA, R.P., NATH, S., Indian J. Physics and Allied Sciences. 8: 98 (1954).

BHATIA, S.L., "The vital capacity of the lungs". Indian Medical Gazette. 64: 519 (1929).

BOUHUYS, A., Bulletein De Physio-Pathologie Respiratorie. 6: 561 (1970).

BROEBECK, J.R., Best and Taylor's Physiological Basis of Medical Practice Tenth Edition. The Williams and Wilkins Company, Baltimore, USA (1979).

BUREAU OF PRODUCT STANDARDS. Size Designation and Body Measurements for the Sizing of Girls' and Female Teens' Ready To Wear Clothing. Philippine National Standard 209 UDC 687.13.3 (1988).

BUREAU OF PRODUCT STANDARDS. Size Designation and Body Measurements for the Sizing of Men's Sports and Knitted Shirts. Product Standards Agency. Philippine National Standard 61. UDC 687. 141 (1984).

BUREAU OF PRODUCT STANDARDS. Size Designation and Body Measurements for the Sizing of Infants'Garments. Philippine National Standard 133: UDC 687.1 (1988).

BUREAU OF PRODUCT STANDARDS. Size Designation and Body Measurements for the Sizing of Boys' and Teen Males' Ready To Wear Clothing. Philippine National Standard 14 UDC 687.13.2 (1988)

BUREAU OF PRODUCT STANDARDS. Size Designation and Body Measurements for the Sizing of Women's Ready To Wear Clothing. Philippine National Standard 210. UDC 687. 12.(1989).

CHANDRA, H., "Birth weight of Indian infants of different economic groups in Hyderabad", proc. Nutrition Society of India. 10: 99 (1971).

CHEN WENBIN ET AL., A Formula for Determining the Healthy Adult's Normal and Estimated Lung Function Values Using an Electronic Pulmometer, Journal of the West China University of Medical Sciences, 19(2): 184-188 (1988) [In Chinese].

CHINESE ACADEMY OF MEDICAL SCIENCES, HYGIENE RESEARCH INSTITUTE, Table of Food Constituents, 3rd Edition, People's Hygiene Press (1989) [In Chinese].

CHINESE ACADEMY OF PREVENTIVE MEDICINE, NUTRITION AND FOOD HYGIENE RESEARCH INSTITUTE, Summary of Research Activities in 1990 on Everyday Diet in China, 10 (1992) [In Chinese].

CHINESE PEOPLE'S REPUBLIC STATE STANDARD GB10000 88, Physical Dimensions of Adults in China, Chinese Standards Press (1989) [In Chinese].

CHINESE PREVENTIVE MEDICINE CENTRE, HYGIENE RESEARCH INSTITUTE, 1982 All-China Nutrition Survey (1985) [In Chinese].

COSTEFF, H., Arch.Dis.Child., 41, 681 (1966).

CRAPO ET AL., "Spirometric Values using techniques and equipment that meet ATS Recommendation", Am. Revue Respire DIS 123: 659-664 (1981).

CURRIMBHOY, Z., "Growth and development of Bombay children". Indian J. Child Health. 12: 627 (1963).

DANG, H.S., JAISWAL, D.D., WADHWANI, C.N., DACOSTA, H., SOMASUNDARAM, S., "Intake of trace elements by Indian infants through breast milk and commercial milk formulae". Proc. Conf. Trace element Analytical Chemistry in Medicine and Biology, held at Neuherberg (West Germany): 37 (1983).

DANG, H.S., Role of Trace Elements in Infant Nutrition. Ph.D. Thesis submitted to Bombay University, (1984).

DANG H.S., DESAI, H.B., JAISWAL, D.D., KAYASTH, S.R., Somasundaram, S., Wadhwani, C.N., DaCosta, H., "Some major and trace elements in human milk and commercial milk formulae". Proc. INDO-FRG Seminar on methodological approaches for the estimation of low dose effects of radiation and chemicals in the environment, held in Bombay (India), 248 (1983).

DANG, H.S., DESAI, H.B., KAYASTH, S.R., JAISWAL, D.D., WADHWANI, C.N., SOMASUNDARAM, S., "Daily requirement of Fe, Co, Se during infancy". J. Radio-anal. Nucl. Chem. 84: 177 (1984).

DE LEON, G. et.al., "Elemental Composition of Philippine Total Diet Samples". Philippine Nuclear Journal. vol.7 p. 29-39 (1990).

DE, P., DE, L.N., "The vital capacity of the Bengalis". Indian Medical Gazette. 74: 409 (1939).

DU BOIS, D., DU BOIS, E.F., "A formula to estimate the approximate surface area if height and weight are known". Arch. Internal. Med. 17, 863 (1916).

DU BOIS, D., DU BOIS, E.F., Arch.Int.Med., 15, 868 (1915).

ELLIS, R. E., "The distribution of active bone marrow in the adult". Phys. Med. Biol., 5, 255-258 (1961).

FOOD AND NUTRITION RESEARCH INSTITUTE, 1990 Food Composition Tables, Philippines. Food and Nutrition Research Institute, Manila, Philippines.

GHAI, O.P., SANDHU, K.K., "Study of physical growth of Indian children in Delhi", Indian J. Pediatr. 35: 91 (1986).

GOPALAN, C., RAMASASTRI, B.V., BALASUBRAMANIAN, S.C. Nutritive values of Indian foods (Revised Edition). National Institute of Nutrition, Hyderabad, India. (1991).

HA HUY KHOI, BUI THI NHU THUAN, "Assessment of some physical measures of rural and Hanoi children at present time", Applied nutrition, Proc. of the International Conf. On Appl. Nutrition, Hanoi 25-29 April 1986, NIN Viet Nam and UNICEF, pp 311-321 (1986)

HASHIMOTO, M., "The distribution of active marrow dose in the bones of normal adult". Kyushu J. Med. Sci., 1, 103-111.

HONDA, Y., "On Respirative Physiology, in Characteristics of the Human Body and Other Relevant Factors in Dose Assessment", Proc. 16th NIRS Seminar on Environmental Research (ed. H. Kawamura and Y. Ohmomo], National Institute of Radiological Sciences, Chiba, Japan, 189-196 (1989).

HONG, J.E., J.Kor.Med.Soc., 16, 202 (1973).

HUARD P., DO XUAN HOP, Morphologies Humaine et Anatomie Artique Coll. de la Direction de l'instruction publique de l'Indochine, Hanoi (1943).

INDIAN COUNCIL OF MEDICAL RESEARCH (ICMR), Review of results obtained during the period 1.4.52. to 31.3.59. Industrial Health Unit, All India Institute of Hygiene and Public Health, Calcutta.

INDIAN COUNCIL OF MEDICAL RESEARCH (ICMR), Growth and Physical Development of Indian Infants and Children. Technical Report Series No.18. ICMR Publication, New Delhi, (1989).

INDUSTRIAL ADVANCEMENT ADMINISTRATION, A Study on the National Anthropometric Survey in Republic of Korea, (1986).

INTERNATIONAL ATOMIC ENERGY AGENCY, Working Material, Project Formulation Meeting, IAEA/RCA CRP on Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, Mito City, Japan (1988).

INTERNATIONAL ATOMIC ENERGY AGENCY, Working Material IAEA-J3-RC-4, Compilation of Anatomical, Physiological and Metabolic Characteristics for a Reference Asian Man, Research Co-ordinating Meeting, Bombay, 8-12 April 1991 (1991).

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Report of the Task Group on Reference Man, ICRP Publication 23, Pergamon Press, Oxford (1975).

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION PUBLICATION NO 23, Reference Man: Anatomical, Physiological and Metabolic characteristics (Translation in Russian), "Medicine" - Moscow (1977).

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Annual Limits on Intakes by Workers, ICRP Publication 30, Part 1, Annal. ICRP 2(3/4) (1979).

JAIN, S.C., MEHTA, S.C., DOGRA, T.D., CHANDRASHEKHAR, N., REDDY, A.R., NAGRATHNAM, A., "Organ weights in autopsy cases from an urban apex hospital". Indian J. Med. Res. 96: 37 (1992).

JAIN, S.K., RAMAIHA, T.J., "Normal standards of pulmonary function tests for healthy Indian men. Comparison of different regression equations". Indian J. Med. Res. 57: 145 (1969).

JOINT GROUP FOR THE SURVEY OF GROWTH OF RURAL CHILDREN IN TEN PROVINCES, Survey Material on the Growth of Rural Children Below Seven Years of Age in 10 Provinces of China (1987) [In Chinese].

KAMAT, S.R., SARMA, B.S., RAJU, V.R.K.S., VENKATRAMAN, C., KULKARNI, S.T., MALHOTRA, S., "Indian Norms for Pulmonary Functions". J. Assoc. Physicians of India, 25: 531 (1977).

KAWAMURA, H., TANAKA, G., MIAH, F.K., RAB MOLLA, M.A., WANG, J., DANG, H.S., SUNTA, C.M., SOEGIARTO, C., KOYANAGI, T., KIM, Y.J., ATTA, M.A., AKHTER, P., NATERA, E.S., NGUYEN, M.L., AND GRIFFITH, R.V., "IAEA-RCA Co-ordinated Research Programme: Compilation of Anatomical, Physiological, and Metabolic Characteristics for a Reference Asian Man", Proceedings of the 9th International Congress of the International Radiation Protection Association, 8-12 April, 1996, Vienna, Austria (1996).

KHAN, A.H., TRAFDAR, et al, "The status of trace and minor elements in some Bangladeshi foodstuffs", Journal of Radioanalytical and Nuclear Chemistry, Articles, Vol. 134, No.2, 367-381 (1989).

KIM, Y.J., LEE, K.S., CHUN, K.J., KIM, J.B., CHUNG, G.H., KIM, S.R., Journal of the Korean Association for Radiation Protection, 7, 1 (1982).

KIM, Y.J., LEE, K.S., CHUN, K.J., KIM, J.B., KIM, S.R., CHUNG, G.H., Journal of the Korean Association for Radiation Protection, 8, 1 (1983).

KIM, Y.J., LEE, K.S., KIM, J.B., CHUN, K.J., KIM, S.R., CHUNG, G.H., KAERI/RR-333/81 (1982).

KNUDSON R.J. ET AL. "Changes in the normal expiratory flow - Volume curve with growth and aging". Am. Rev. Respire. DIS 127; 725-734 (1993).

KORY R.C. ET AL. "The veterans administration Army Cooperative Study of Pulmonary Function". J. Clinical Spirometry in Normal Men. Am. J. Med. 30: 243-258 (1961).

KRISHNAN, B.T., VAREED C., "A further study of vital capacity of south Indians". Indian J. Med. Res. 21: 131 (1933).

KRISHNAN, B.T., VAREED, C., "The vital capacity of 103 male medical students in South India". Indian J. Med. Res. 19: 1165 (1932).

KRISTUFEC P. ET AL. "Reference Values Modelling of age, body height and mass". Bull. Eur. Physiological Respire 23: 139-147 (1987).

KUNO Y., Human Perspiration. Charles C. Thomas Publisher, Springfield, Illinois, USA, (1969).

LUNDGREN, P.V., SENGUPTA, A., SAHA, P.N., "Lung volumes and maximal breathing capacity among Indian men with sedentary occupation". Alumini Assoc. Bulletin. 1 (1953).

MINISTRY OF HEALTH AND WELFARE, Kokumin Eiyo-no Genjo (Report of the National Nutrition Survey for the year of 1975), and succeeding annual report to the year of 1986, Dai-ichi Shuppan, Tokyo (in Japanese) (1978-88).

MINISTRY OF EDUCATION, SCIENCE AND CULTURE, Report of the School Health Survey, MEJ 6908, MEJ 3-7816 and succeeding annual report to MEJ 3-8903, Ministry of Finance Printing Bureau, Tokyo (in Japanese) (1978-89).

MIYAMURA, M. AND HONDA, Y., "Maximum cardiac output related to sex and age". Jpn. J. Physiol., 23, 645-565 (1973).

MONDIERE, Cité par Huard P. Bigot A: "Les caracteristiques anthropologiques des Indochinois". Trav. de l'Institut Anat. de l'Ecole Sup. de Med. de l'Ind. Tom IV - Hanoi, p.15 (1938).

MOTHERS' AND CHILDREN'S HEALTH AND WELFARE ASSOCIATION, Report on the Growth of Infants and Preschool Children, 1990 and preceding reports, Boshi Eisei Kenkyu-kai, Tokyo (in Japanese) (1991).

MUKHERJEE, H.N., GUPTA, P.C., "The basal metabolism of Indians and Bengalis". Indian J. Med. Res. 18: 807 (1981).

NATIONAL NUTRITION SURVEY REPORT (1985-87) NIH, Islamabad, Pakistan.

NISHIDA, O. ET AL., Jpn. J. Clin. Pathol., 24, 837-841 (1976).

ORGANIZATION DE SANTE MONDIALE, Mesure de l'impact nutritional, Traduction en langue Russe - Geneve (1985).

RAGHUNATH, V.M., SOMAN, S.D., "Water Intake Data for Indian Standard Man". Environmental Health, 11: 1 (1969).

RAGHUNATH, V.M., VENKATRAMAN, K., MURTHY, H.S.R.C., Somasundaram, S., "Preliminary results of certain pulmonary physiological norms in Indian adults". Health Physics, 11: 287 (1965).

RAGHVAN, P., NAGENDRA, A.S., "A study of ventilatory functions in healthy Indian adults". J. of Postgraduate Medicine. Vol.II, No.3: 99 (1965).

RAJALAKSHMI AND RADAKRISHNAN, C.U., Progress Report Dept. of Biochemistry, Baroda University (1969).

REDDY, D.V.S., SASTRY, P.B., "Studies in vital capacity". Indian J. Med. Res. 32: 269 (1944).

NATIONAL NUTRITION MONITORING BOARD (NNMB), Report on the Repeat Survey of Rural Population for Nutritional and Anthropometric Status (1988-90). National Institute of Nutrition (ICMR), Hyderabad, India.

NATIONAL NUTRITION MONITORING BOARD (NNMB), Report on the rural population: Nutritional and Anthropometric Survey (1980), National Institute of Nutrition, Hyderabad, India.

NATIONAL NUTRITION MONITORING BOARD (NNMB), Report on the urban population: Nutritional and Anthropometric Survey (1984), National Institute of Nutrition (ICMR), Hyderabad, India (1984).

RESEARCH SECTION OF THE CONSTITUTION AND HEALTH OF CHINESE STUDENTS, Research of the constitution and health of Chinese students, P788, People's Education, Press (1987).

ROA, C. ET. AL., "Normal Standards for Ventilatory Function Tests in Adult Filipinos". Philippine Journal of Internal Medicine. vol. 25, pp.185-193 (1987).

SANTOS, E. "A Comparative Study on Pulmonary Function Test Between the Morris and the Filipino Standards". Scientific Proceedings. vol.1 no.3, pp. 277-283 (1989).

SHIRAISHI, K., YOSHIMIZU, K., TANAKA, G. AND KAWAMURA, H., "Daily intake of 11 elements in relation to Reference Japanese Man. Health Phys. 57, 551-557 (1990).

SHIRAISHI, K., IGARASHI, Y., YOSHIMIZU, K., TAKAKU, Y. AND MASUDA, K., "Daily intake of ^{232}Th and ^{238}U in Japanese males". Health Phys. 63, 187-191 (1992).

SINGH, H.D., PARBHAKARAN, S.J., "Pulmonary function studies". J. Indian. Med. Assoc 29: 269 (1961).

SINGH, H.D., "Ventilatory function tests in female children and adults". J. Indian Med. Assoc. 31: 203 (1958).

SINGH, H.D., "Ventilatory function tests in male adults". Current Medical Practices. 5: 214 (1961).

SNYDER, W.S., FORD, M.R., WARNER, G.G., FISHER, H.L.J., Nucl. Med. Suppl. (MIRD Pamphlet No.5) (1978).

SUBARAMU, M.C., "An index of risk for inhalation hazard evaluation". Health Physics. 27: 353 (1974).

SURVEY GROUP FOR THE CONSTITUTION AND HEALTH OF BEIJING STUDENTS, Trends in the Body Development and Growth of Beijing Students over the Last 50 Years and Analysis of the Influencing Factors: Study of the Constitution and Health of Chinese Students. People's Education Press, 788-817 (1985) [In Chinese].

SWAMINATHAN, M.S., "Semilongitudinal study of growth and development of Indian children and related factors". Indian Pediatr. 1: 255 (1964).

TAKASHI MARUYAMA, A Mathematical Phantom for the Determination of Dose to Organs at Risk, Annex 8

TANAKA, G.I., KAWAMURA H. AND NAKAHARA, Y., "Establishment of Reference Japanese". J. At. Soc. Japan, 19, 674-679 (in Japanese) (1977).

TANAKA, G.I. KAWAMURA, H. AND NAKAHARA, Y., "Reference Japanese Man-I. Mass of organs and other characteristics of normal Japanese". Health Phys. 36, 333-346 (1979).

TANAKA, G.I., KAWAMURA, H. AND NOMURA, E., "Reference Japanese Man-II. Distribution of strontium in skeleton and the mass of mineralized bone". Health Phys., 40, 601-614 (1981).

TANAKA, G.I., "Japanese Reference Man 1988 III, Masses of organs and tissues and other physical properties", NIPPON-ACTA Radiologica 48(4):509 (1988).

TANAKA, G.I., NAKAHARA, Y., NAKAJIMA, Y., "Japanese Reference Man 1988-IV". Nippon Acta Radiologica. 1988: 96 (1988).

TANAKA, G.I., NAKAHARA, Y. AND NAKAJIMA, Y. (1989). "Japanese Reference Man 1988-IV. Studies on the weight and size of internal organs of normal Japanese". Nippon Acta Radiologica, 49, 344-364 (in Japanese with tables and figures in English) (1989).

TANAKA, G.I., "Reference Japanese Man". Hoken Butsuri 25, 49-60 (in Japanese) (1990).

TANAKA, G.I., Reference Japanese Vol. 1, NIRS-M-85, National Institute of Radiological Sciences, Chiba, Japan (1992).

TANAKA, G.I., Anatomical and physical characteristics for Asian Reference Man-a Proposal. NIRS-M-95, National Institute of Radiological Sciences, Chiba, Japan (1993).

TANCHOCO, C. ET AL., Third National Nutrition Survey Philippines. 1987. Part B Anthropometric and Clinical Survey. FNRI Publication (1989).

TELANG, D.H., BHAGWAT, G.A., Studies on the vital capacity of Bombay Medical Students. 29: 723 (1941).

THOMSON WELLS, J.M., Indian J. Tuberculosis. 1: 69 (1954).

TRAFDAR, S.A., ALI, M., ISLAM, A., KHAN, A.H., "Level of some minor and trace elements in Bangladeshi meat products", Journal of Radioanalytical and Nuclear Chemistry, Articles, Vol. 152, No.1, 3-9 (1991).

VENKATRAMAN, K., SOMASUNDARAM, S., SOMAN, S.D., "An evaluation of radiation protection standards for Indian conditions". Health Physics. 9: 647 (1963).

VENKATRAMAN, K., RAGHUNATH, V.M., SANTHNAM, K., SOMASUNDARAM, S., "Physiological norms in Indian adults - statistical analysis of data on organ weights". Health Physics. 12: 572 (1966).

VIET NAMESE MINISTRY OF HEALTH, Biological Constants of Viet Namese, Medical Publishing House - Hanoi, (1975).

VYAS, G.N., SATHE, M.S., PURANDHARE, N.M., SATOSKAR, R.S., "Red Cell, Plasma and Blood Volume in Indians Belonging to Low and High Socio-Economic Groups". Indian J. Med. Res. 53: 682 (1982).

WANG, J. ET AL, "Reference values of body height and weight in China", Chin. J. Radial. Med. Prot. 13(1):3, (1993).

YAMAGUCHI, H. ET AL., "The transformation method for the MIRD absorbed fraction as applied to various physiques". Phy. Med. Biol., 20, 593-601 (1975).

YOSHIZAWA, S., ISHIZAKI, T. AND HONDA, Y. (1975).

ZHANG YINGSHAN ET AL., The Height and Body Weight of the Chinese "Reference Man" and His Preliminary Trial Application in Radiation Protection Standards, Nuclear Protection 1: 1 (1979) [In Chinese].

ZHANG YINGSHAN ET AL., Certain Physiological Parameters of Chinese Adults, Proceedings of the First Symposium of the Chinese Radiation Protection Society, Atomic Energy Press 32 (1982) [In Chinese].

ZHANG YINGSHAN AND WANG ZHAOZHI, Functional Changes in the Thyroid Glands of Children in Certain Regions of China, Radiation Protection 7(5): 367 (1987) [In Chinese].

ZHU HONGDA AND ZHANG JINGYUAN, "Investigation of food radioactivity and estimation of internal dose by ingestion in China", Proc. CAMS and PUMC 2(1):7 (1987).

PARTICIPANTS IN THE CO-ORDINATED RESEARCH PROGRAMME

BANGLADESH

Md. Fazle Karim Miah	Health Physics Division Atomic Energy Center P.O. Box 164, Dhaka - 2
M.A. Rab Molla	Nuclear Safety & Radiation Protection Division Bangladesh Atomic Energy Commission P.O. Box 158, Ramna, Dhaka-2

CHINA

Jixian Wang	Department of Radiation Effects Institute of Radiation Medicine Chinese Academy of Medical Sciences P.O. Box 71 Tianjin

INDIA

Harry S. Dang	Low Level Counting Laboratory B.A.R.C. Hospital Anushakti-Nagar, Bombay-94
Chintamani Sunta	Radiation Safety Division Atomic Eenergy Regulatory Board V.S. Bhavan, Bombay

INDONESIA

Chrys Sugiarto	PSKR-BATAN, J1, CINERE PASAR JUMAT, PO Box 43/KBYL Jakarta Selatan

JAPAN

Hisao Kawamura	Division of Radioecology National Institute of Radiological Sciences 3609 Isozaki Nakaminato Ibaraki, 311-12
Taku Koyanagi	Institute for Environmental Sciences 504-20 Nozuki, Obuchi Rokkasho-Mura, Aomori-ken, 039-32
Gi-ichiro Tanaka	Division of Radioecology National Institute of Radiological Sciences 3609 Isozaki Nakaminato Ibaraki, 311-12

REPUBLIC OF KOREA

Jung Jin Kim

Department of Biology
Chungnum National University
301-764, Daejon, 300

MALAYSIA

Manmohan Yadav

Institute of Advanced Studies
University of Malaya
59100 Kuala Lumpur

PAKISTAN

Manzoor Ahmad Atta

Health Physics Division
Pakistan Institute of Nuclear Science &
Technology
PINSTECH, Islamabad

PHILIPPINES

Erlinda S. Natera

Health Physics Research Group
Philippine Nuclear Research Institute
Diliman, Quezon City

THAILAND

Poonsuk Pongpat

Health Physics Division
Office of Atomic Energy for Peace, Vibhavadee
Rangsit Road, Bangkhen, Bangkok 10900

VIET NAM

Nguyen Manh Lien

Viet Nam National Atomic Energy Institute
67 Nguyen Du
Hanoi

97-05340