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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	LA	HA	RA	LA	HA	
China			M	5.76	4.08	6.63						
			F	4.35	2.95	5.64						
India	2,620 504	17-54	M	4.90	3.30	8.10						
			F	3.70	2.20	5.70						
Japan	192 70	20-25	M	5.67	4.23	5.10	10.20	87.00	2.448	4.896	41.762	
			F	4.05	2.90	4.20	8.40	52.50	2.016	4.032	5.20	
Philippines	25 25	20-45	M	5.00	3.50	14.86	22.60	49.01	7.133	10.848	23.52	
			F	4.21	2.70	10.74	21.62	42.64	5.155	10.378	20.46	
Viet Nam	357 284	20-50	M	4.43	3.63							
			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	20-50 20-50	M	4.53	4.40
			F	3.60	
Japan	9 6	18-21 19-22	M	3.31	3.30
			F	2.70	2.70
Philippines	40 116	20-45 20-45	M	3.40	1.31
			F	2.96	1.27
Viet Nam	6 6	20-39 20-39	M	2.53	2.48
			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.