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DETERMINATION OF DAILY INTAKE OF ELEMENTS FROM PHILIPPINE TOTAL DIET SAMPLES USING INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY

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ABSTRACT

Total diet samples were analyzed for major elements (Na, K, Ca, Mg, P) and some minor/trace elements (Fe, Zn, Mn, Al, Sr, Cu, Ba, Yb) using Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES). Samples analyzed were classified into sex and age groups. Results for some elements (Ca, K, Mg, Zn, Cu, Fe) were compared with the values from National dietary survey calculated using the Philippine Food Composition Table. Except for Na, analytical results were similar to calculated values. Analytical results for Ca and Fe were also compared with the values from the Food and Nutrition Research Institute. In general, values obtained in the study were lower than the FNRI values. Comparison of the analytical and calculated results with the Japanese and ICRP data showed that Philippine values were lower than foreign values.

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1.0 BACKGROUND

In the fields of radiation protection and nutrition, knowledge on the elemental intakes of man is very important. In nutrition, information on the total contents of food intakes, including trace elements, could greatly contribute to the improvement of human nutrition through better assessment and planning. In radiation protection, on the other hand, the determination of stable elements in diet and tissues is very vital for the calculation of metabolism parameters concerning uptake and deposition of radionuclides in the human body.

A total diet is composed of many kinds of foods - cereals, meat and meat products, fish and other marine products, vegetables and fruits - all of which consist of varying amounts of different elements. At present, however, there is still a dearth of information on the quantity of elemental constituents of dietary intakes, most especially in Asian countries.

Recently, some types of data banks which could provide information on national food supply as well as per capita nutrient intakes have been available. One is the Food and Agriculture Organization's (FAO) interlinked computer storage and processing system. However, only major components - vitamins and major minerals - are currently stored in the FAO data bank (1). A few countries now have their own Food Composition Table (FCT). Also, data on national food supply are available from individual countries' Food Balance Sheets. Nevertheless, these data do not take into consideration the wide variation in intake among different individuals in a population (1), thus, for radiation protection purposes, these are not advisable to use in the calculation of age and sex specific elemental intakes from total diet.

In the Philippines, the Food and Nutrition Research Institute (FNRI) has published a Food Composition Table (2) which gives information on the nutrient contents of some 1323 food items. However, although this FCT provides a lot of useful information/data, it still has some limitations like incomplete analysis of the food composition components, relatively large variations in values obtained, and absence of analysis for fast foods, which are at present very popular especially in urban

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areas. Food consumption surveys are also performed by the FNRI every five years (3,4,5). The main objective of the survey is to assess the food situation and nutritional status of the population, but the data provided are not sufficient for use in radiation protection because it is not age and sex specific (assumed equal shares for all members including children) and it was performed only for one season of the year.

For an accurate concentration and age and sex specific dietary intake estimates of elements, an application of a reliable analytical method of analysis is recommended. Nevertheless, in the absence of sophisticated equipment and costly materials necessary for quantitative analysis, calculations based on site specific dietary survey and FCT could be considered.

During the past few decades, great progress in analytical measurement has been accomplished. The improvement made possible the reliable analysis of food samples, not only for major, but also for minor and trace elements. Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) is an analytical method commonly employed today in food sample analysis. Shiraishi, et, al. (6,7,8,9,10) have conducted studies on elemental composition of Japanese diet. Among Asian countries at present, Japan has the most number of information on the elemental constituents of dietary samples.

The PNRI, in connection with the dose projection study of the mothballed Philippine Nuclear Power Plant (PNPP-1), conducted a dietary survey of 885 families composed of 4469 individuals, (11, 12) in the vicinity of the PNPP-1 (Bataan) which is a rural area. The survey covered a one week food consumption period, and specified the age and sex of individuals. The quantity of some elements on the daily food intakes from the Bataan survey is at present being calculated using the FNRI Food Composition Table. The elements are limited to Na, K, Mg, Zn, Cu, Mn, and I, which are the only ones available from the FCT. Likewise, calculations of these elements in diet using some data from the Food and Nutrition Research Institute (FNRI) were undertaken.

This study, aims to conduct quantitative analysis of Philippine total diet samples - determining some major, minor and trace elemental composition - and to compare the results with the calculated values from the Bataan survey and some limited FNRI data.

The study also hopes to provide information on the conduct of quantitative analysis of food samples to other developing countries participating in the project "Establishment of Asian Reference Man" which aims to obtain a uniform set of data by using a standard procedure.

2.0 METHODOLOGY

As a general rule, the analysis of diet samples must take into account a number of factors like the nature of the sample, the analytical instruments/techniques to be applied, and the materials, facilities, and method to be used.

2.1 Nature of Sample

The study aims to determine dietary elemental composition of Philippine total diet samples. Sample collection was confined to middle income residents of Metro Manila during the months of November, December and January. These samples were classified into the following age groups:

3 - 10	Children
11 - 20	Teenagers
21 - 40	Young Adults
41 & above	Elder Adults

The Filipino dietary intake could be classified into three general categories: 1) commercially prepared foods, 2) unprocessed fresh foods, and 3) table ready meals. In this study, the third one was used, apolying duplicate meal sampling.

2.2 The Instrument : ICP-AES

Several studies (6, 7, 9, 10, 18, 19, 20, 21, 22) have demonstrated the specific capabilities of Atomic Emission Spectroscopy using ICP and direct current plasma (DCP) for the determination of many elements in food samples. Jones (14) showed that Na, K, P, Ca, Mg, Fe, Zn, Cu, Mn, and Sr can be routinely determined in a wide variety of foods using conventional pneumatic nebulization ICP-AES.

This study made use of a Shimadzu ICPQ - 1012W ICP-AES to simultaneously determine elements of interest. The operating condition applied is given in Table 1 below.

Table 1: Operating Condition

Plasma Torch		
Operating frequency		27.120 MHz
Operating power		1.2 kw
Nebulizer		concentric
Load coil		2 turns
Argon gas flow rate,	carrier	1.0 l/min
	coolant	11.5 l/min
	plasma	1.5 l/min

Sample uptake rate	2.5 ml/min (deionized water)
Observation height above load coil	1.5 cm (nominal)
Polychromator	
Grating	Holographic, 2700 grooves/mm
Mount	Paschen-Runge 1.0 m focal length
Reciprocal linear dispersion	0.37 nm/mm
Entrance slit width	20 um
Exit slit width	50 um
Photometric System RE-12	
Photomultipliers	21
Alkali detectors	Na, K
Integration time	20 s
Data Acquisition System	
Processor	MELCOM 70/L
Program	QC-5D

Table 2, on the other hand, shows the analytical lines used:

Table 2 : Analytical Lines Used

Element	Wavelength (nm)
Na (I)	589.00
K (I)	766.49
P (I)[a]	213.62
Ca (I)	422.67
Mg (I)	383.83
Fe (II)	259.94
Zn (II)	202.55
Mn (II)	257.61
Al (I)	396.15
Sr (II)	407.77
Cu (I)	324.75
Ba (II)	455.40
Cr (II)	267.72
Ni (II)	231.60
Mo (II)	281.62
Cd (II)	226.50
Co (II)	228.60
Y (II)	371.03

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[a]Second order

2.3 Materials and Facilities

Tools and containers used for food sample analysis should be made of materials that contain very low concentrations of the elements of interest. Sample containers must be suitable for storage without degradation especially when acids are added. Adsorption of most elements from solution is less on polyethylene than on glass. With a few exception, almost all sorption losses can be eliminated by the addition of acid (13). Polyethylene and pyrex containers were used in the study.

It should also be kept in mind that in addition to the composition of container, its cleaning is another source of contamination, hence extra care must be taken. Each worker should develop his/her own cleaning procedure to obtain minimum blanks for the determination at hand. All containers used were first washed with detergent and hot tap water, then rinsed with purified H_2O, soaked in HNO_3 solution for 1 day, and finally soaked in purified H_2O for another day, before rinsing with the same, and drying in a laminar flow. The dry containers were then doubly sealed in plastic sheet containers, ready for use.

It is of fundamental importance to ensure that the quality of chemical reagents used is acceptable for analytical work since they may be a major source of contamination depending on their purity, the concentration level of the element to be analyzed, and the method of analysis to be used (14). The increasing demand for ultra-pure acids resulted in the establishment of many commercial suppliers. Now, the question of how long the reagents have been in the container after manufacture, with resultant contamination, has become a problem. This is aggravated by the fact that some manufacturers do not appreciate the need for careful choice of container and its pretreatment (15). Analysts must therefore be extra careful in getting the correct reagent from the right source. In this study, super-analytical grade hydrochloric, nitric and perchloric acids were used. These acids were obtained from a reliable chemical supplier in Tokyo.

Another important requirement of an analytical laboratory, especially those performing trace element analysis, is a reliable and continuous supply of pure water. Thus, it is very important to determine regularly the quality of prepared water, in order to be certain that there has not been a breakdown in purification. In this study, freshly purified water was prepared from tap water using a Barnstead D-2794 four-module system attached with a hose-nipple to a two-bed ion exchange cartridge. Preparation of pure water from such source was closely monitored to ensure its purity.

A minimum requirement for laboratories performing trace element analysis is a "clean bench". A class 100 clean air hood or bench-top canopy is absolutely essential (15). To attain class 100 conditions, laminar flow is essential together with the use of high efficiency particulate air filters (HEPA). Such has a

minimum efficiency rating of 99.97% for 0.3 um particles (16). In the study, acid digestion and subsequent procedures for sample preparation were carried out in a class 100 clean air hood, installed in a clean room.

2.4 Method

2.4.1 Drying

During oven drying of food samples, it is important to control the temperature since at around 100°C and above, the biological matrix may decompose, depending upon the nature of the sample, and this may result in loss of residual dry matter and intrinsically volatile elements (14). Recommended drying temperature is between 60-80°C.

2.4.2 Homogenization

The analyst should see to it that sample used in the analysis is a representative of the sample to be analyzed.

2.4.3 Dry Ashing

The temperature for dry ashing varies but an upper limit of 450°C is recommended since at temperatures around 500°C volatilization of a large number of elements such as Ag, As, Co, Cr, Hg, I, K, Na, Pb, Sb, Se, Sn, and Te, may occur (21). Samples can be ashed for about 16 to 24 hours. Ashing time depends on the type and quantity of the material (13).

3.0 PROCEDURE

3.1 Sample and Sample Collection

Each diet sample was prepared in private homes under the guidance of a researcher. Each sample consisted of three full meals - breakfast, lunch and supper, and two snacks - morning and afternoon. Samples include liquid intakes like water, coffee, milk, tea, softdrinks, and juice.

Samples collected were placed in plastic containers and transported to PNRI for drying. To ensure that no significant change in sample composition occurred during the sampling, transport, and storage steps, sample collection was cautiously performed by one of the authors.

3.2 Sample Preparation

The edible portion of the diet sample was separated, placed in a pyrex container, weighed, mixed thoroughly, and dried

in an oven at 60°C, half covered. Drying time was about one week per sample.

Sample materials were thoroughly mixed again after drying to enhance homogeneity. However, regardless of the care taken to homogenize the sample materials, a sub-sample may not always be representative of the whole sample (13). Hence, to lessen the error arising from the heterogeneity of the composite, three random aliquot portions from each sample were taken for analysis.

Dried samples were placed in porcelain dish separately, and ashed in an electric muffle furnace at 450°C. Ashing time was about 20 hours. Ashed samples were weighed and then stored in polyethylene vials prior to analysis.

3.3 Preparation of Sample Solution

The procedure developed by Shiraishi, et, al. (6, 7, 8, 9, 10) was applied to the dry ashed food samples. An aliquot, approximately 0.25 g, was taken and placed in a vacuum oven at about 80°C for two hours before re-weighing. Then it was digested in a 50 ml borosilicate glass beaker covered with watch glass, containing about one (1) ml concentrated nitric acid, at temperature between 100 - 150°C for about two hours, before drying up at about 200°C. This was done in a Thermolyne HP-11415B ceramic top hot plate. About one (1) ml concentrated nitric acid and 0.5 ml 61% percholoric acid were added next, and digestion was repeated.

When the mixture turned white, it was dried up at about 200°C. About one (1) ml concentrated HCl was then added to convert the nitrate into chloride, and the mixture was heated at about 80-100°C for about two hours, then dried. The white solid was then dissolved in freshly prepared purified water and a few drops of concentrated HCl, with gentle heating until a clear solution was obtained. The solution was cooled, filtered, and the volume was made to 25 ml with the addition of purified water. Polyethylene vials were used to contain the prepared sample solutions.

The prepared solution has 1% ash content and 0.25M HCl concentration. Compatibility of the ashing procedure with post digestion chemistry and the determinative step is critical. For example, excessively high dissolved solid content of a test solution caused by milligram or gram quantities from the food material itself, can cause intolerable instrument difficulties for ICP-AES due to volatilization interference or to test solution introduction problems. For most determinative methods, a test solution with a relatively low matrix salt content (1-2% dissolved solids) free of suspended particulates is most readily compatible (15).

During the digestion procedure, care was taken to introduce only minimum amount of acids to lessen the possibility of contamination.

3.4 Preparation of NBS Standards

Four sets of NBS SRM 1577A Bovine Liver standard (revised 3/1/86) weighing one gram each were prepared, applying similar procedure used for the food samples.

3.5 Preparation of Standard Solutions

Stock solutions (1000 ug cm^{-3}) were prepared by dissolving standard materials in HCl and then diluting with purified water. The "Specpure" materials containing Ca, Mg, K, Na, Fe, Zn, Cu, Mn and Sr were obtained from Johnson Matthey Chemicals, Royston. Standard solutions were prepared in two groups by diluting the stock solutions. The first was for major elements - Na, K, Ca, Mg, and P, and the second for the minor and trace elements.

3.6 Elemental Analysis

For major element analysis (Na, K, Ca, Mg, and P), food sample solution was further diluted 25 times with a final HCl concentration of 0.1N. Using the ICP-AES operating conditions shown in Table 1, matrix matching between the sample solutions and the standard solution were performed.

Calibration curve for each of the analyte was made using four (4) concentrations, e.g., 0, 250, 500 and 1000 ug/ml of the analyte.

On the other hand, minor and trace elements - Fe, Zn, Mn, Al, Sr, Cu, Ba, and Y - in the sample solutions were determined using matrix matching method without dilution.

4.0 RESULTS AND DISCUSSIONS

4.1 Analysis of NBS Sample

The major elements in NBS standard were determined first before the minor elements. The value obtained were in good agreement with the certified NBS value, i.e., 5 % difference.

For minor elements, the results also showed good agreement with the NBS Certified value with error of 5% except for Fe (16%).

Analytical results for both major and minor elements are shown in Table 3.

Table 3: Analytical Results for NBS Standard

Element	Concentration (ug/g dry weight)		% Recovery
	Observed Value	Certified NBS Value	
Na	2335 ± 96	2430 ± 130	96
K	965 ± 55	996 ± 7	97
Ca	117 ± 6	120 ± 7	98
Mg	581 ± 20	600 ± 15	97
P	1105 ± 62	1110 ± 40	99.5
Fe	226 ± 29	194 ± 20	116
Zn	126 ± 16	123 ± 8	102
Cu	165 ± 21	158 ± 7	104
Mn	9.8 ± 0.24	9.9 ± 0.8	99

4.2 Concentration of Major, Minor and Trace Elements

For the sixteen diet samples, the mean concentration of the major elements - Na, K, Ca, Mg, and P - is shown in Table 4.

A wide variation in matrix as shown by the big standard deviation was observed in comparing with the Japanese diet samples (6,7). This is due to the limited number of samples used in the analysis. A three-day total diet for each sample, and a

bigger number of samples are generally recommended to get a narrower matrix range.

Concentration of every matrix element in the standard solution was chosen as close as possible to the results. Deviation in the matrix concentration between the standard and sample solution was within ±25%.

Table 4: Concentration of Major Elements in Dietary Sample Solutions and those of the Standard Matrix Derived

Element	* Mean concentration of sample (ug cm^{-3})	Concentration of standard matrix (ug cm^{-3})
Na	1958 ± 251	1950
K	996 ± 202	1000
Ca	374 ± 152	300
Mg	155 ± 30	170
P	685 ± 137	690

* Mean and SD from 16 samples

Table 5 and 6, on the other hand, show the major, minor and trace elements by age and sex.

Table 5 : Concentration of Major Elements by Age and Sex

Age Group	Sex	n	Elemental Intake, gram/day/person				
			Na	K	Ca	Mg	P
3-10	M	2	2.16 ± 0.71	0.58 ± 0.27	0.23 ± 1.04	0.12 ± 0.62	0.52 ± 0.15
	F	1	1.45 ± 0.01	0.55 ± 0.10	0.18 ± 0.04	0.14 ± 0.02	0.62 ± 0.08
11-20	M	1	2.56 ± 0.10	1.14 ± 0.06	0.39 ± 0.02	0.28 ± 0.02	1.10 ± 0.06
	F	1	3.17 ± 0.15	0.95 ± 0.04	0.46 ± 0.02	0.16 ± 0.01	0.82 ± 0.02
21-40	M	4	1.60 ± 0.68	0.81 ± 0.06	0.34 ± 0.11	0.12 ± 0.02	0.50 ± 0.10
	F	5	1.54 ± 0.45	0.80 ± 0.14	0.26 ± 0.16	0.12 ± 0.03	0.44 ± 0.17
41 & above	F	2	2.31 ± 1.82	1.17 ± 0.82	0.38 ± 0.05	0.17 ± 0.12	0.62 ± 0.28

* For sample where n=1, SD is the deviation of 3 measurements

Table 6: Concentrations of Minor and Trace Elements by Age and Sex

Age Group	Sex	n	Elemental Intake, mg/day/person							
			Fe	Zn	Mn	Al	Sr	Cu	Ba	Y*
3-10	M	2	3.24 ± 0.26	6.16 ± 1.36	2.15 ± 0.16	1.20 ± 0.32	1.36 ± 0.55	0.93 ± 0.13	0.07 ± 0.00	0.6 ± 0.2
	F	1	1.26 ± 0.23	5.79 ± 1.15	3.60 ± 0.48	4.88 ± 1.30	1.46 ± 0.22	2.50 ± 0.01	0.20 ± 0.04	0.7 ± 0.3
11-20	M	1	3.86 ± 0.10	8.41 ± 0.46	2.49 ± 0.08	1.60 ± 0.07	2.47 ± 0.06	1.21 ± 0.06	0.09 ± 0.01	1 ± 1
	F	1	9.50 ± 1.14	11.19 ± 0.58	2.72 ± 0.16	2.53 ± 0.16	1.45 ± 0.09	1.40 ± 0.06	0.36 ± 0.03	2 ± 0.4
21-40	M	4	6.17 ± 2.86	6.56 ± 3.23	1.82 ± 0.38	2.42 ± 1.18	1.05 ± 0.30	0.76 ± 0.11	0.17 ± 0.04	1 ± 0.2
	F	5	5.37 ± 1.18	4.91 ± 1.91	1.62 ± 0.77	2.01 ± 0.88	0.99 ± 0.16	0.71 ± 0.26	0.20 ± 0.07	1 ± 0.7
41 & above	F	2	7.06 ± 2.98	6.76 ± 0.99	2.65 ± 1.14	3.32 ± 1.94	1.31 ± 0.76	1.21 ± 0.42	0.40 ± 0.26	2 ± 1

* ug/day/person

In general, some differences between elemental intakes by age and sex could be observed, however, because of the limited number of samples used, a conclusive analysis could not yet be made.

4.3 Comparison of Observed Results with Calculated Data

As mentioned earlier, the dietary elemental intake of some elements i.e., Na, K, Mg, Zn, Cu, and Mn from Bataan survey data are at present being calculated (17) using the currently available data of 11 rural barangays, composed of 1,612 individuals. A comparison was made between quantitative data and the Bataan data. Tables 7A - 7D show the results of the comparison.

Table 7A: Comparison of Analytical with Calculated Values for Children (mg/day/person)

Age Group	Element	Calculated		Analytical	
		Male N=235	Female N=208	Male N=2	Female N=1
3 - 10	Na	133 ± 321	103 ± 172	2160 ± 710	1450 ± 10
	K	698 ± 896	669 ± 607	580 ± 270	550 ± 100
	Mg	121 ± 129	114 ± 118	115 ± 24	140 ± 20
	Zn	2.91 ± 3.27	2.91 ± 3.68	6.16 ± 1.36	5.79 ± 1.15
	Cu	0.63 ± 0.47	0.63 ± 0.46	0.93 ± 0.13	2.50 ± 0.01
	Mn	1.80 ± 1.25	1.75 ± 1.54	2.15 ± 0.16	3.60 ± 0.48

* For samples where N=1, SD is the deviation of 3 measurements

For both male and female children, Na values from analytical study are significantly higher than calculated values. This could perhaps be attributed to food seasoning added during cooking like salt, soy sauce etc. which contain NaCl. Such contribute a part in the elemental composition in food samples analyzed but could not be accounted for in the calculated value.

For K, Mg, Zn, Cu and Mn there is in general no significant difference between the calculated and analytical results.

The observed values for K are however too low. Children ages 3-10 usually take milk which has about 1600 mg/li K.

Table 7B: Comparison of Analytical and Calculated Values for Teens (mg/day/person)

Age Group	Element	Calculated		Analytical	
		Male N=222	Female N=190	Male N=1	Female N=1
11 - 20	Na	142 ± 224	115 ± 187	2560 ± 100	3170 ± 150
	K	781 ± 691	658 ± 462	1140 ± 60	950 ± 40
	Mg	176 ± 256	147 ± 169	280 ± 20	160 ± 10
	Zn	4.64 ± 6.42	4.35 ± 5.13	8.41 ± 0.46	11.19 ± 0.58
	Cu	0.84 ± 0.43	0.75 ± 0.40	1.21 ± 0.06	1.40 ± 0.06
	Mn	2.51 ± 1.84	2.27 ± 1.64	2.49 ± 0.08	2.72 ± 0.16

For teens, the values followed the trend observed for children.

Table 7C: Comparison of Analytical and Calculated Values for Young Adul
(mg/day/person)

Age Group	Element	Calculated		Analytical	
		Male N=238	Female N=235	Male N= 4	Female N=5
21 - 40	Na	137 ± 165	191 ± 297	1600 ± 680	1540 ± 450
	K	762 ± 611	1029 ± 938	810 ± 60	800 ± 140
	Mg	195 ± 266	198 ± 232	120 ± 20	120 ± 30
	Zn	5.54 ± 7.60	5.23 ± 6.42	6.56 ± 3.23	4.91 ± 1.91
	Cu	1.04 ± 1.31	1.12 ± 0.83	0.76 ± 0.11	0.71 ± 0.26
	Mn	3.16 ± 3.06	3.10 ± 2.46	1.82 ± 0.38	1.62 ± 0.77

Like for children and teens, Na values of both male and female in the analytical study are significantly higher than the calculated values, whereas there is no significant difference for values of K, Mg, Zn, Cu and Mn.

Table 7D: Comparison of Analytical and Calculated Values for Elder Adu
(mg/day/person)

Age Group	Element	Calculated		Analytical
		Male N=147	Female N=137	Female N=2
41 and above	Na	142 ± 138	150 ± 132	2310 ± 1820
	K	893 ± 811	939 ± 710	1170 ± 820
	Mg	156 ± 190	177 ± 195	170 ± 120
	Zn	4.61 ± 6.20	4.79 ± 5.35	6.76 ± 0.99
	Cu	1.07 ± 0.62	1.02 ± 0.72	1.21 ± 0.42
	Mn	2.93 ± 2.33	2.97 ± 2.89	2.66 ± 1.14

For elder adults, the trend of values is also similar to that of children, teens, and young adults.

Thus, except for Na, analytical results are similar to calculated values. Again, however, the small number of samples analyzed is a limitting factor in the meaningful comparative results between elemental dietary intakes for quantitative analysis and calculated values.

4.4 Comparison of Analytical Results with FNRI Data

In 1974, the Food and Nutrition Research Institute (FNRI), as part of their nationwide nutrition survey, determined the mean one day per capita nutrient intake of Filipinos, by age group, in the Luzon provinces. This phase of the study was however discontinued in their succeeding nationwide surveys (10, 11, 12). The calcium and iron intakes data from the FNRI 1974 study which so far provide the only age specific values were compared with the analytical study conducted and are shown below.

Table 8 : Comparison of Analytical with FNRI Values

A. Children (mg/day/person)

Intake	FNRI 1974			Analytical 1989-90
	4-6 years n = 222	7-9 years n = 175	Ave (4-9 yrs) n = 397	3-10 years n = 3*
Ca (g)	0.24	0.25	0.24	0.23/0.18**
Fe (mg)	8.4	9.30	8.80	3.24/1.26**

* Two males, one female
** Male/female

For children, calcium intake of male in the study is comparable with the FNRI combined value for both sex. However, female intake in the former is lower compared to the latter.

For iron, the values obtained in the study are significantly lower than the FNRI values for both male and female.

B. Teens (mg/day/person)

Intake	FNRI 1974		Analytical 1989-90	
	10 - 19 years		11 - 20 years	
	Male n=275	Female n=286	Male n=1	Female n=1
Ca (g)	0.33	0.26	0.39	0.46
Fe (mg)	11.70	7.03	3.86	9.50

For the teens, calcium intakes in the study conducted are higher for both male and female compared with the FNRI data. For iron, on the other hand, intake of male is lower while intake of female is higher than the FNRI values.

C. Young Adults (mg/day/person)

Intake	FNRI 1974		Analytical 1989-90	
	20 - 39 years		21 - 40 years	
	Male n=304	Female n= 276	Male n=4	Female n=5
Ca (g)	0.42	0.32	0.34	0.26
Fe (mg)	14.1	10.9	6.17	5.37

For young adults, male intake of calcium in the study is in between the intake of male and female in the FNRI study, while calcium intake of female is lower in the former. For iron, on the other hand, values of both male and female in the study are lower than the FNRI values.

D. Elder Adults (mg/day/person)

Intake	FNRI 1974		Analytical 1989-90
	40 and above		41 and above
	Male n=137	Female n=158	Female n = 2
Ca (g)	0.40	0.32	0.38
Fe (mg)	13.38	10.90	7.06

For elder adults, calcium intake in this study is higher than that of female but lower than that of male in the FNRI study. Iron intake, on the other hand, is lower than both male and female intakes in the latter.

In general, values obtained in this study were lower than the FNRI values. This is interesting to note because with a 15-year difference in time, a better nutrition could be expected. But of course food is relatively more expensive today than before and could also possibly cause poor nutrition.

The FNRI value provided data of the entire Luzon, a bigger area, covering both urban and rural localities. Hence difference in food availability and individual priority based on some factors like taste, cost, culture etc. could be expected which could probably cause the observed differences in values obtained. The limited number of analytical samples used though could be the biggest limiting factor in the observed differences.

4.5 Comparison of Results with Other International Values

Comparison of the analytical and calculated results with the Japanese and ICRP data are shown in Table 9. Values showed that Philippine values for both were lower than foreign values.

Table 9: Comparison of Observed Results with other Values

Element	Phil (Analytical) Values *	Phil (Calculated) Values *	Japanese[8] Values	ICRP Reference[5] Man Values	Ratio Phil(Anal)/ICRP	Ratio Phil(Calc)/ICRP
Na (g)	1.57	0.16	4.5	4.4	0.36	0.04
K (g)	0.81	0.89	1.9	3.3	0.24	0.27
Ca (g)	0.30		0.56	1.1	0.27	
Mg (g)	0.12	0.20	0.20	0.34/0.27**	0.35/0.44**	0.59/0.74**
P (g)	0.47		0.92	1.4	0.34	
Fe (mg)	5.72		12	16/12 **	0.38/0.45**	
Zn (mg)	5.64	5.38	7.1	13	0.43	0.41
Al (mg)	2.19		4.0	4.5	0.49	
Mn (mg)	1.71	3.13	3.4	3.7	0.46	0.84
Sr (mg)	1.01		2.3	1.9	0.53	
Cu (mg)	0.73	1.08	1.3	3.5	0.21	0.31
Ba (mg)	0.18		0.36	0.48	0.38	

* Mean of age group 21-40
** Male/Female

5.0 CONCLUSION

Analytical results from the analysis of total diet samples were, in general, similar to the calculated results from Bataan survey, but showed some differences compared with the PNRI values. However, because of the limited number of samples analyzed a conclusive analysis could not yet be deduced from these results.

The observed analytical and calculated results were in general lower compared with the Japanese values, and much lower than the ICRP values. This clearly shows the necessity of having a Reference Asian Man for radiation protection purposes.

Toward this end, more diet samples will be analyzed to have representative quantitative data. A three-day total diet sample will be used for analysis in order to get a smaller matrix variation. Sampling in Metro Manila, to represent urban area, as well as in selected rural areas will be tried. Also, calculations based on dietary survey from Metro Manila will be carried out to have an idea of the calculated values from the urban area and be able to fairly compare with urban analytical results and rural analytical and calculated values. Economic status of the rural and urban sample population for both the analytical and calculated studies will be considered to have a better profile of the country's dietary characteristics.

As a whole, the methodology could be used as guide by other member countries of the IAEA Coordinated Reference Man project who are just starting to obtain elemental composition of dietary samples.

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