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Original Article

Agreement of estimated values with measured values in dietary intakes of minerals: A validation study in Japan

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Abstract

This study was initiated to examine the validity of newly published food composition tables (FCT) as a tool for estimation of mineral intakes in Japan. For this purpose, 24-hour food duplicate samples were collected from residents in two areas. In practice, 24 adult women in one area and 17 adults (men and women) in the other offered complete samples (i.e. the samples with which the energy intakes were ≧1.2 times basal metabolic rates). The concentrations of nine minerals (Ca, Cu, Fe, K, Mg, Mn, Na, P and Zn) in the duplicates were estimated by use of FCT, and compared with the values measured by flame atomic absorption spectrometry or inductively-coupled plasma atomic emission spectrometry. Close agreement was observed between the estimated values (E) and the measured values (M) on a group basis; the E/M ratios were in a range of 0.92–1.26. Lower limits of the 95% confidence interval of the ratio were, however, low, i.e. 0.42 for Ca, 0.54 for Na and 0.59 for Fe. The risk of over-estimation was highest for Mg (by +26%), Fe (by +22%) and Mn (by +22%). Thus, it appeared prudent to conclude that FCT-based estimation is reliable on a group basis for the minerals studied, and that care should be practiced, however, when application is made on an individual basis, especially for Ca, Fe and Na.

Keywords: Estimation; Food composition tables; Instrumental analysis; Mineral intake; Validation

1. Introduction

Eating healthily is a common wish of people (e.g. Margetts et al., 1997; Zunft et al., 1997), and it is the first step in the primary prevention of illness and the measure which everyone can practice in daily life. Because valid food composition tables (FCT) are the starting point of the nutrient intake estimation, validation of FCT as a tool for the estimation of dietary intake of nutrients has been a study subject of this group (Moon et al., 1996; Shimbo et al., 1999; Zhang et al., 1999; Kim et al., 2003).

It has been reported that deviation of the FCT-based estimates from correct (e.g. instrumentally measured) values is generally small for macro-nutrients (Nakaji et al., 1996; Kim et al., 2003; Yoshita et al., 2005). The deviation has, however, been shown to be rather large for minerals and, accordingly, attention of the present study group has been focused on minerals rather than on macro-nutrients (Moon et al., 1996; Shimbo et al., 1999; Zhang et al., 1999). Accurate knowledge on mineral intake is an important issue, e.g. iron for prevention of anaemia among women of reproductive ages and calcium in relation to osteoporosis among aged people (World Health Organization 1992; Cohen and Roe 2000; Institute of Medicine 2001; Ikeda et al., 2006). In fact, the current levels of intakes of these minerals meet only barely with the corresponding recommended dietary allowances among people in Japan (e.g. Matsuda-Inoguchi et al., 2004; Ministry of Health, Labour and Welfare Japan, 2006).

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A new version of FCT was published recently in Japan (Council for Science and Technology Japan, 2005). The present study was initiated to examine the validity of this new Japanese FCT as a tool to estimate intakes of nutrient minerals, by comparing the FCT-based estimates with the instrumentally measured values. The results were compared with past validation to know if the revision has brought in any improvement in the estimation.

2. Subjects, materials and methods

2.1. Study subjects and anthropometry

Two surveys were carried out in Japan in 2004; one survey was in Osaka, the largest city (with a population of about 2.6 million) in western Japan (Area A), and the other in the fishing village of Karakuwa (with about 10,000 residents) on the Pacific coast in eastern Japan (Area B). The two areas were selected taking contrasts into consideration, i.e. a large city versus a small village, and western Japan versus eastern Japan.

In practice, 26 healthy adult women (mostly housewives) volunteered to participate in the survey in Area A (Group A), and 21 healthy adults (6 men and 15 women; mostly from fishing families) joined the survey in Area B (Group B). The anthropometric characteristics and energy intake by these 41 subjects (24 and 17 for Group A and Group B, respectively) are summarized in Table 1. The grand mean age (i.e. for men and women in the two areas in combination) was 60 years; a majority (18 cases) was in an age range of 60–69 years, followed by 13 cases in 50–59 years. The grand mean body mass index (BMI) was about 23.

In anthropometry, body weight was measured as clothed and without shoes. The measured body weight was adjusted for weight of clothes by subtracting 1 kg so that body weight (in kg) = [measured body weight–1].

Each participant provided his/her informed consent to join the study, and the protocol of the study was approved by the Ethics Committee of Kyoto University Graduate School of Medicine and the Faculty of Medicine, Kyoto, Japan.

2.2. Collection of food duplicate samples

One 24-hour food duplicate sample (including snacks and drinks; Acheson et al., 1980; World Health Organization, 1985) was collected from each participant. The protocol of food duplicate collection and processing of the collected samples were previously described in detail (Matsuda-Inoguchi et al., 2001). In short, each donor of the food duplicate sample was carefully instructed to prepare everyday meal (i.e. no special dishes for social occasions; Matsuda-Inoguchi et al., 2001) for his/her family including one additional hypothetical member and save a duplicate portion of each meal (of the amount he/she ate) in acid-washed plastic containers (4–5 containers per meal, and therefore 10–15 containers per day; solid foods such as boiled rice were saved in boxes, and liquid food such as soup and milk were saved in wide-mouthed bottles). Each donor was asked also to submit the meal menu (i.e. names of each plate together with names of food materials used) of the day. Care was taken to minimize errors due to under- or over-reporting (Samaras et al., 1999; Hebert et al., 2002; Murakami, 2004) through intensive communications on the study purpose and assurance of privacy protection.

Each food item in the sample was manually separated and weighed, and the weights were recorded in reference to the submitted menu under supervision of veteran nutritionists who knew local foods well (Matsuda-Inoguchi et al., 2001). The separation was made by use of non-metal tableware (e.g. bamboo chopsticks) to avoid mineral contamination. Only edible portions were collected. Thus, in case of fish, for example, bones, fins and viscera (if not taken together) were removed and only meats were collected. Skins were peeled off in case of fruits such as apples and oranges. The weights were measured by use of electronic balances.

Table 1
Anthropometry and energy intake data of the food duplicate donors

Item	Unit	Group[a]				
		A	B		A + B	
		Women	Men	Women	Women	Men + women
Number		24	3	14	38	41
Age	yr	61.2 ± 4.9	46.0 ± 26.5	59.7 ± 12.5	60.6 ± 8.4	59.6 ± 10.7
Height	cm	152.6 ± 4.6	168.1 ± 8.0	152.3 ± 7.1	152.5 ± 5.6	154 ± 7.0
Weight	kg	53.7 ± 5.2	64.4 ± 18.8	54.3 ± 8.7	53.9 ± 6.6	54.7 ± 8.1
BMI	kg/m^2	23.1 ± 2.1	22.5 ± 5.0	23.5 ± 3.8	23.2 ± 2.8	23.2 ± 2.9
Energy intake	kcal/day	1894 ± 277	2174 ± 366	1963 ± 290	1920 ± 280	1938 ± 289

Values are arithmetic mean ± arithmetic standard deviation.
[a]Group A; residents in the city of Osaka. Group B; residents in the fishing village of Karakuwa.