

Divergence and agreement on nutrient intake between the two food composition tables of Bangladesh

Masum Ali¹  | Md Ruhul Amin² 

¹Helen Keller International, Dhaka, Bangladesh

²Institute of Nutrition and Food Science (INFS), University of Dhaka, Dhaka, Bangladesh

Correspondence

Md Ruhul Amin, Institute of Nutrition and Food Science (INFS), University of Dhaka, Kazi Nazrul Islam Avenue, Dhaka-1000, Bangladesh.
Email: ruhul.infs@du.ac.bd

Abstract

In Bangladesh, two food composition tables (FCTs) were published over two consecutive years, in 2012 and in 2013. When different databases are used to calculate nutrient intakes, assessment of divergence and agreements is required. This study aimed to compare the differences in nutrient intakes, to assess the similarities in nutrient intakes between the two FCTs, and to explore the factors that cause the difference in nutrient intakes, if any. A total sample of 40 households was taken from the Household Income Expenditure Survey of 2010. Adult male equivalent (AME) units were used to estimate weighted average intake. Weighted *k* statistics were used to assess agreements between the two FCTs. Although median intake of energy and energy-yielding nutrients (protein, fats, and carbohydrates) were found statistically significant between the two databases, the differences were not large enough to have practical significance. Excellent agreements were found in energy and carbohydrates with good for fats and fair for protein. However, statistically significant median percent differences were seen in beta carotene (441%), vitamin B6 (153%), and folate (129%), vitamin C (106%), zinc (101%), and iron (41%) intakes. For thiamin, iron, calcium, and phosphorous, more than 50% of the subjects were found in the same quintile, whereas nine out of 15 vitamins and minerals were misclassified into the opposite quintiles ($\geq 10\%$). Fair agreements were found for most of the micronutrients. Variations in analytical methods and sources of nutrient information were the main contributing factors for actual differences. FCT data should be interpreted with caution, especially for micronutrients.

KEYWORDS

adult male equivalent (AME), Bangladesh, food composition table (FCT), food-based dietary guideline, macronutrients, micronutrients, nutrient intakes

1 | INTRODUCTION

Food composition tables (FCTs), a foremost source of the nutritionally important components of food consumed by mass populations, provide values of energy and nutrients such as protein, fats,

carbohydrates, vitamins, and minerals. Additionally, FCTs provide information on nonnutritive components of food related to their beneficial and detrimental effects on health (Elmadfa & Meyer, 2010). Thus, FCTs have been extensively used for developing food and nutrition policy, dietary guidelines, training manuals, and nutrition

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2020 The Authors. Maternal & Child Nutrition published by John Wiley & Sons Ltd

recommendations for targeted population. They are important on monitoring the nutritional quality of food and protecting consumers for trade and business purposes (Leclercq, Valsta, & Turrini, 2001). Furthermore, FCTs are widely used in health communication programs, sometimes labelled as social marketing, to promote food of high nutritional value to reduce the burden of communicable and non-communicable diseases (Schönfeldt & Gibson, 2010).

In Bangladesh, the first FCT, known as “Deshiokhaddo Pustiman,” was published in 1977 by the Institute of Nutrition and Food Science (INFS) of the University of Dhaka (INFS, 1977). In 1979, the second FCT was published by Institute of Public Health and Nutrition (IPHN, 1979). These FCTs were published in the Bengali language. Later in 1988, Helen Keller International Bangladesh in collaboration with World Food Program and INFS published an English version of the national FCT with a special emphasis on vitamin A. This FCT included food composition values from former FCTs used in Bangladesh and borrowed composition values of food that were commonly consumed in Bangladesh from the FCTs of neighbouring countries and food data generated by government and nongovernment organizations (Darnton-Hill, Hasan, Karim, & Duthie, 1988). Almost two decades later, in 2012, a new FCT named “Food Composition Table and Database for Bangladesh with Special Reference to Selected Ethnic Food (FCTB-2012)” was published from INFS. It included the newly analysed nutritional values of 93 foods that were identified as key foods for general and ethnic population through a food consumption survey in the Chittagong Hill Tracts region. FCTB-2012 also included nutrient information of 388 food items from several sources such as previous FCTs and published and unpublished food composition data generated by INFS and other organizations (Islam, Khan, & Akhtaruzzaman, 2012). One year later, another FCT named “Food Composition Table for Bangladesh (FCTB-2013)” was published from INFS by Shaheen et al. (2013). This FCT included the analysed food composition values of 20 key foods that were selected from the household consumption data of the Household Income and Expenditure Survey (HIES) 2010 of Bangladesh considering priority food and nutrients for the Bangladeshi population. Nutritive values of all other food items of the FCT were collected from various research articles and national and international FCTs and incorporated in the FCT following the International Network of Food Data Systems (INFOODS) guidelines (Shaheen et al., 2013). The reason for developing the consecutive FCTB-2013 was that the FCTB-2012 did not consider some issues such as moisture and fat adjustment, the food specific nitrogen conversion factor for protein content, and total dietary fibre found in energy content of foods. Additionally, FCTB-2012 was not in line with the INFOODS guidelines (Shaheen et al., 2013).

The two FCTs, FCTB-2012 and FCTB-2013, published over two consecutive years from the same institute are widely being used to quantify the nutrient intake of diets (Rahman et al., 2017; Rahman et al., 2016; Deptford et al., 2017; Harris-Fry et al., 2018; Al Hasan et al., 2016; Campbell et al., 2018). However, variations of nutrient values in FCTs, resulting either from newly analysed foods or from borrowed data, lead to different estimates of nutrient intakes and adequacies (Ahuja, Goldman, & Perloff, 2006; Hels et al., 2003; Yamini, Juan,

Key messages

- Excellent agreements were found for energy and carbohydrates, good for fats, and fair for protein. However, statistically significant differences were found in beta-carotene, vitamin B6, folate, vitamin C, zinc, and iron intakes between the two databases.
- Variations in analytical methods and sources of nutrient information were the main contributing factors for actual differences.
- FCT data should be interpreted with caution, especially for micronutrients. A review of the FCTs with a special focus on micronutrient contents is vital for having a reliable and valid FCT for Bangladesh.

Marcoe, & Britten, 2006). Thus, it is essential to examine comparability and to look for agreements when different databases are concurrently used for calculating the nutrient intakes of subjects living in the same or different countries (Deharveng, Charrondiere, Slimani, Southgate, & Riboli, 1999). Therefore, this study aims to compare the differences in nutrient intakes of a sample population and to assess the agreements regarding nutrient intakes between the two FCTs. Further, this study aims to explore the factors that cause the difference in nutrient intakes, if any.

2 | METHODS

2.1 | Subjects

This study used dietary data from the HIES, a national survey held in 2010 and conducted by the Bangladesh Bureau of Statistics. It surveyed 12,240 households including rural and urban areas. In HIES 2010, direct household members' food consumption data were not collected, but the survey recorded all the food items and their quantities that were used in the households in across 14 consecutive days using seven visits by the enumerators to each household every 2 days. The food consumption section contained 138 food items that covered all the food items that were consumed within the households and away from households. The selection criteria of this study were as follows: first, households that were consuming foods from all food groups such as cereals, pulses, meats, fishes, eggs, leafy and nonleafy vegetables, sugars, beverages, and spices because nutrient databases provide a comprehensive list of all food groups; and second, a sample size that would allow us to conduct necessary statistical tests. Therefore, after scrutinizing all the areas and food items of the HIES, we selected 40 households from a rural area of Shibgonj thana in the Chapainobabgang district of Bangladesh. This study avoided large sample sizes because although they often produce extremely

significant results, the effect size is small; on the other hand, small samples result in a larger effect size of practical importance (Lantz, 2013). Furthermore, the HIES did not provide intrahousehold food distribution patterns, which limited the disaggregated analysis of nutrient consumption based on age, gender, and biological and economic status of the individuals (Waid et al., 2018). The food consumption data of these selected households were processed using the two FCTs (FCTB-2012 and FCTB-2013) used in Bangladesh. In addition, we concentrated on major food items that are commonly consumed in Bangladesh and that contributed into dietary energy.

2.2 | Coding and data preparation

Food items of the selected 40 households were first coded manually using the food codes of FCTB-2012 and then recoded using FCTB-2013 food codes since food codes in HIES-2010 data were not the same as FCT codes. This coding process was cross-checked by the authors. The coded food items that were selected from FCTB-2012 represented similar food items of FCTB-2013 regarding name, variety, and species. SPSS version 16.0 was used to process all food intake information. Food intakes were collected over 14 consecutive days so that average intakes were calculated for every food item. Every food item was summed for 14 days and then divided by 14 days to calculate the average intake. SPSS syntax was prepared separately for handling the data properly. First, we used the syntax of FCTB-2012 food codes and prepared a nutrient intake dataset for FCTB-2012. Then, we ran the syntax of FCTB-2013 food codes for preparing another nutrient intake dataset of FCTB-2013. Finally, we combined the datasets for analysis. During data coding, recoding, and processing, extra caution was taken to minimize the name, variety, and species errors compared with the raw database of HIES-2010 as nutrient information varied by variety and species. The quality of the data was assessed using descriptive statistics and logic checks.

2.3 | Standardization of calculation procedures

Food items in HIES-2010 contained single or multiple foods in one line. Although the selected households did not consume all the listed food items, frequently consumed food items were selected in case of multiple foods found in one line. However, HIES-2010 had a few food items that were collected in multiples. Since nutrient information was available in per 100 g raw weight of food in both FCTs, the consumed numbers of foods were then converted into their equivalent weights in terms of grams. It is to be noted that information on food items was recorded in raw weight that was as purchased from the market, so the edible coefficient for every food item was adjusted before calculating the equivalent nutrients from raw food weight (Ali & Pramanik, 1991). Furthermore, nutrient losses during cooking were taken into consideration for water- and fat-soluble vitamins and minerals. Nutrient retention and other factors were adjusted during calculation of nutrient intakes for both FCTs (Bell et al., 2006).

2.4 | Weighted average nutrient intakes calculation

Dietary data in HIES-2010 were collected from households without mentioning any proportion of consumption of an individual household member; therefore, adult male equivalent (AME) units related to age and sex were assigned to each household member. According to the Food and Agriculture Organization, AMEs are calculated as the ratio of a particular age and sex to the energy requirement of an adult male aged 18 to 30 years, with moderate physical activity taken into consideration. Total household nutrient intakes were then divided by the total AMEs of a household for estimation of the individual nutrient intake of a household (Bermudez, Lividini, Smitz, & Fiedler, 2012). All individual intakes were then weighted to get an average intake of an individual per day. However, the status of pregnancy or lactating women was not recorded in HIES-2010, and age of infants in months was missing as well. So all infants aged 7 to 11 months were treated as younger than 1 year as a whole, and all women were considered as non-pregnant and nonlactating.

2.5 | Statistical analysis

Nutrient values that were matched in terms of measurement unit in both FCTs were examined in this study. Weighted average intake of energy and 18 nutrients were calculated using the two databases (FCTB-2012 and FCTB-2013). All statistical analysis was performed using SPSS. Normality was checked by the Shapiro-Wilk test. Data of nutrients were not normally distributed. Thus, median values and interquartile range were reported as a measure of central tendency. The Wilcoxon signed-rank test and nonparametric paired *t* test were carried out to detect the statistical significance that was defined as $p < .05$. Spearman correlation and energy-adjusted partial correlation were calculated to report the associations between nutrient intakes. Furthermore, weighted nutrient intakes were classified into quintiles, and then weighted *k* statistics were used to assess agreement between the two FCTs.

3 | RESULTS

3.1 | Energy and energy-yielding nutrients

Median intakes of energy and energy-yielding nutrients were calculated for FCTB-2012 and FCTB-2013 (Table 1). Nearly 3–5% of median differences were found for carbohydrates, protein, and fats. However, energy, protein, fat, and carbohydrate intakes were statistically significant between FCTB-2012 and FCTB-2013. Significant differences were found in the contribution of protein, fats, and carbohydrates to energy.

Scatter diagrams for energy and energy-yielding nutrients estimated using FCTB-2012 and FCTB-2013 are presented in Figure 1.

TABLE 1 Median intake and median differences for energy and energy-yielding nutrients estimated using FCTB-2012 and FCTB-2013

Nutrient	FCTB-2012		FCTB-2013		Median paired difference ^a		
	Median (25th, 75th)	IQR	Median (25th, 75th)	IQR	Median (25th, 75th)	% ^b	p value ^c
Energy (kcal)	2,961.5 (2,363.4, 3,314.4)	951	2,953.0 (2,356.9, 3,276.1)	919.2	16.7 (-2.8, 34.6)	1	.002*
Protein (g)	70.5 (60.4, 77.6)	17.2	75.2 (65.4, 82.4)	17	-3.6 (-6.1, -2.2)	-5	<.001*
Fats (g)	29.5 (22.7, 36.9)	14.1	28.4 (22.2, 34.7)	12.5	0.9 (0.0, 1.6)	3	<.001*
Carbohydrates (g)	596.8 (477.4, 665.9)	188.5	569.7 (451.5, 642.1)	190.6	24.9 (18.9, 33.1)	4	<.001*
Protein (E %)	9.8 (8.9, 10.4)	1.4	10.4 (9.5, 11.1)	1.6	-0.6 (-0.9, -0.4)	-6	<.001*
Fats (E %)	9.1 (7.7, 10.7)	3.1	9.0 (7.6, 10.4)	2.8	0.2 (-0.1, 0.4)	2	.006*
Carbohydrates (E %)	81.0 (79.0, 82.2)	3.2	77.7 (76.1, 78.6)	2.5	3.2 (2.5, 3.8)	4	<.001*

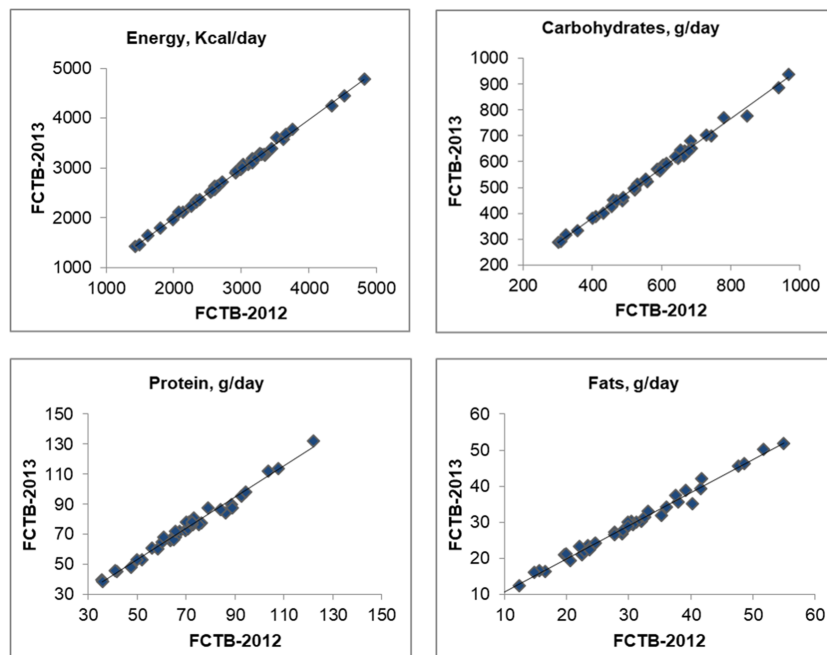
Abbreviation: IQR = interquartile range.

^aMedian paired difference = FCTB-2012 minus FCTB-2013.

^b% (median percent difference) = median paired difference divided by the FCTB-2012 median value.

^cp values are for differences between FCTB-2012 and FCTB-2013 (Mann-Whitney).

*Statistically significant ($p < .05$).

**FIGURE 1** Scatter diagrams of energy and energy-yielding nutrient intakes

The intake values of energy, carbohydrates, protein, and fats were strongly associated between the two FCTs.

Correlation and proportion of subjects classified into the quintiles for agreement on the basis of FCTB-2012 and FCTB-2013 are presented in Table 2. There were strong correlations for protein (.97), fats (.99), and carbohydrates (.99) although the adjusted correlation coefficients were slightly lower than the unadjusted correlation coefficients. All subjects were classified into the same quintile for carbohydrates, and about 85–95% of subjects for energy and fats and 30% of subjects for protein were misclassified into the adjacent quintile. None of the subjects were found in the extreme opposite quintile for energy and energy-yielding nutrients. Kappa statistics indicated an excellent agreement for energy and carbohydrates, a good agreement for fats, and a fair agreement for protein.

3.2 | Vitamins and minerals

Median intakes were not similar between the two nutrient databases (FCTB-2012 vs. FCTB-2013) for vitamin C, beta-carotene, vitamin B₆, folate, zinc, and iron (Table 3). A median difference of more than 400% was found for beta-carotene, followed by 106% for vitamin C, 153% for vitamin B₆, 129% for folate, 101% for zinc, and 41% for iron. However, lower percent median differences were found for sodium, magnesium, niacin, thiamin, calcium, potassium riboflavin, and copper (9–22%, respectively). Out of 15 vitamins and minerals, only niacin and phosphorous were not found to be statistically significant.

The scatter diagram for vitamin C, beta-carotene, folate, vitamin B₆, and zinc is presented in Figure 2. Values of vitamin C, beta-carotene, folate, and zinc were scattered between FCTB-2012 and FCTB-2013, whereas zinc values mainly appeared close to the line.

TABLE 2 Correlations and subjects classified into quintiles for energy and energy-yielding nutrient intakes estimated using FCTB-2012 and FCTB-2013

Nutrient	Spearman correlation	Partial correlation (energy adjusted)	Classified into the same quintile (%)	Classified into the adjacent quintile (%)	Classified into the opposite quintile (%)	Weighted k
Energy (kcal)	.997		95	5		0.938
Protein (g)	.972	.93	70	30		0.625
Fats (g)	.991	.983	85	15		0.812
Carbohydrates (g)	.995	.894	100	0		1
Protein (E %)	.92		72.5	25	2.5	0.656
Fats (E %)	.971		75	25		0.688
Carbohydrates (E %)	.858		42.5	50	7.5	0.281

TABLE 3 Median intake and median differences for vitamins and minerals estimated using FCTB-2012 and FCTB-2013

Nutrient	FCTB-2012		FCTB-2013		Median paired difference ^a		p value ^c
	Median (25th, 75th)	IQR	Median (25th, 75th)	IQR	Median (25th, 75th)	% ^b	
Vitamin C (mg)	69.5 (37.7, 95.8)	58.1	142.8 (69.2, 291.3)	222.2	-73.8 (-198.3, -29.4)	-106	<.001*
Beta-carotene (µg)	591.6 (293.4, 1069.8)	776.4	3,542.8 (1,786.1, 5,512.9)	3726.7	-2,610.6 (-4,591.1, -1,455.4)	-441	<.001*
Thiamin (mg)	1.5 (1.3, 1.8)	0.5	1.2 (1.0, 1.5)	0.5	0.2 (0.2, 0.4)	16	<.001*
Riboflavin (mg)	1 (0.9, 1.3)	0.4	0.8 (0.7, 1.0)	0.3	0.2 (0.1, 0.4)	19	<.001*
Niacin (mg)	24.1 (20.3, 27.4)	7.2	21.3 (18.3, 29.7)	11.4	2.4 (-3.0, 5.3)	10	.333
Vitamin B6 (mg)	0.7 (0.5, 0.8)	0.3	1.7 (1.4, 2.0)	0.6	-1.0 (-1.4, -0.8)	-153	<.001*
Folate (µg)	82.3 (71.4, 97.9)	26.5	191.4 (146.7, 286.4)	139.7	-106.2 (-198.1, -60.8)	-129	<.001*
Copper (mg)	4.9 (3.8, 5.8)	1.9	3.7 (2.9, 4.4)	1.5	1.1 (.6, 1.7)	22	<.001*
Zinc (mg)	7.0 (5.4, 8.6)	3.2	14.1 (12.1, 16.9)	4.8	-7.0 (-8.5, -6.1)	-101	<.001*
Iron (mg)	20.8 (15.9, 33.1)	17.2	13.7 (11.1, 18.2)	7.2	8.6 (4.0, 13.9)	41	<.001*
Calcium (mg)	298.1 (255.9, 407.7)	151.8	248.4 (209.7, 331.4)	121.7	52.1 (35.4, 72.9)	17	<.001*
Magnesium (mg)	629.8 (554.2, 819.0)	264.9	535.7 (465.4, 666.5)	201.1	63.4 (232.4, -9.7)	10	.001*
Sodium (mg)	193.2 (156.8, 262.7)	105.9	157.2 (124.0, 225.8)	101.7	17.9 (-11.3, 63.0)	9	.008*
Potassium (mg)	1,873.0 (1,480.8, 2,146.5)	665.7	2,296.9 (1,722.9, 2,630.7)	907.8	-318.6 (-647.5, -107.9)	-17	<.001*
Phosphorous (mg)	1,251.8 (1,049.0, 1,524.2)	475.2	1,275.1 (1,140.1, 1,564.2)	424.1	-1.4 (-51.6, 60.1)	0	.737

Abbreviation: IQR, interquartile range.

^aMedian paired difference = FCTB-2012 minus FCTB-2013.

^b% (median percent difference) = median paired difference divided by FCTB-2012 median value.

^cp values are for differences between FCTB-2012 and FCTB-2013 (Mann-Whitney).

*Statistically significant ($p < .05$).

The correlation coefficient for vitamins and minerals ranged from .6 to .9 with a lower value for folate (.34), vitamin B6 (.34), copper (.59), and sodium (.55; Table 4). The correlation coefficient with energy adjustment was slightly lower than the unadjusted value; however, the energy adjusted coefficient for vitamin B6, folate, and copper was negative. The proportion of subjects classified into the same quintiles in FCTB-2012 and FCTB-2013 ranged from 50 to 70% for thiamin, riboflavin, iron, and calcium and from 30% to 45% for folate, vitamin B6, vitamin C, beta-carotene, zinc, magnesium, sodium, and potassium. Almost 20% to 50% of subjects were found in adjacent quintiles for all vitamins. Subjects were misclassified into the extreme opposite quintile with 7.5% for vitamin C; 20% for

beta-carotene and sodium; 5% for thiamin, riboflavin, and calcium; 12.5% for niacin; 30% for vitamin B6; 22.5% for copper; 10% for zinc; 15% magnesium; 17.5% for potassium; and 32.5% for folate. Results of the Kappa analysis indicated moderate agreement for thiamin, iron, calcium, and phosphorous and fair or slight agreement for other nutrients.

4 | DISCUSSION

This study examined the divergence and agreements in nutrient intakes estimated using FCTB-2012 and FCTB-2013, as these two

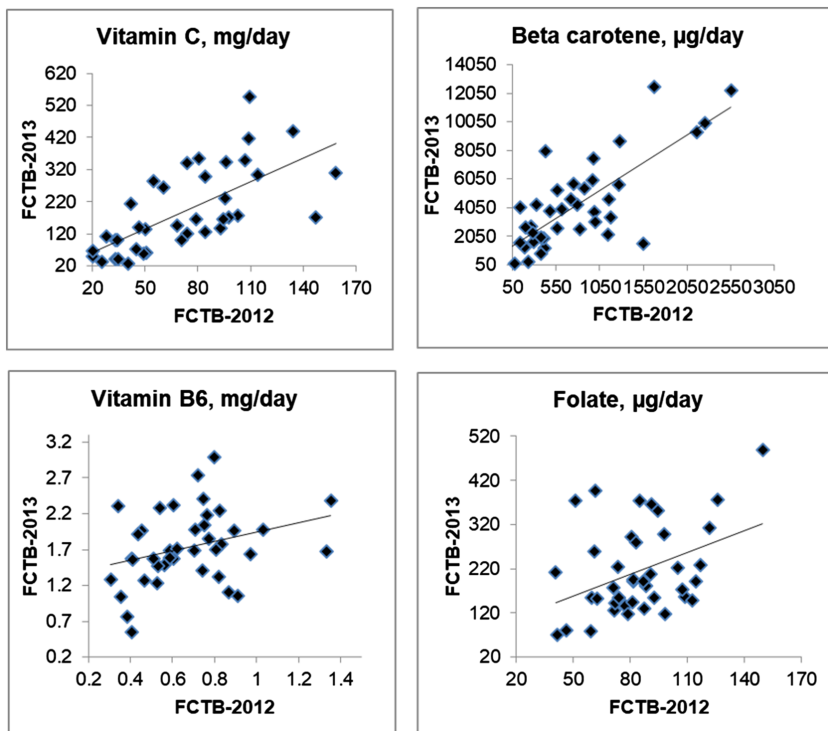


FIGURE 2 Scatter diagrams of vitamin C, beta-carotene, vitamin B6, folate, and zinc intake

TABLE 4 Correlations and subjects classified into quintiles for vitamins and minerals intake estimated using FCTB-2012 and FCTB-2013

Nutrient	Spearman correlation	Partial correlation (energy adjusted)	Classified into the same quintile (%)	Classified into the adjacent quintile (%)	Classified into the opposite quintile (%)	Weighted k
Vitamin C (mg)	.81	.658	42.5	50	7.5	0.281
Beta-carotene (µg)	.68	.857	45	35	20	0.312
Thiamin (mg)	.913	.856	65	30	5	0.562
Riboflavin (mg)	.86	.702	50	45	5	0.375
Niacin (mg)	.771	.322	45	42.5	12.5	0.312
Vitamin B6 (mg)	.341	-.819	35	35	30	0.187
Folic acid (µg)	.34	-.222	35	32.5	32.5	0.187
Copper (mg)	.587	-.157	40	37.5	22.5	0.25
Zinc (mg)	.858	.969	45	45	10	0.312
Iron (mg)	.948	.976	70	30		0.625
Calcium (mg)	.904	.919	67.5	26.5	5	0.594
Magnesium (mg)	.694	.66	30	55	15	0.125
Sodium (mg)	.554	.165	35	45	20	0.187
Potassium (mg)	.754	.677	42.5	40	17.5	0.281
Phosphorous (mg)	.98	.964	80	20		0.75

FCTs were extensively being used to calculate nutrient consumption in Bangladeshi population. Further, it looked at the factors that contribute to the differences in nutrient intakes. Energy-yielding nutrients

were statistically significant and showed strong correlation between FCTB-2012 and FCTB-2013. For energy-yielding nutrients, subjects were not misclassified into the extreme quintile, whereas for

micronutrients, more than 10% of subjects (9 of 15 micronutrients) were misclassified into the opposite quintile. Only iron and phosphorous showed substantial agreement, calcium and thiamin showed moderate agreement, and the rest showed slight or fair agreement. Energy and fats exposed perfect agreement, whereas protein displayed substantial agreement between the two databases. Median differences for energy and energy-yielding nutrients were found to be quite close. However, median intakes were significantly different for the majority of the micronutrients except phosphorous and niacin. A high median percent difference was found for vitamin C (106%), beta-carotene (441%), vitamin B6 (153%), folate (129%), and zinc (101%). Inverse partial correlation was found for vitamin B6, folate, and copper.

Only a few foodstuffs were analysed for nutrients in both nutrient databases, and the nutrient values of other foods were borrowed from different sources. Therefore, variation in laboratory techniques and sources of secondary data could be important factors for the differences in nutrient intakes generated from FCTB-2012 and FCTB-2013. In addition, the Indian FCT had been playing a significant role in Bangladeshi nutrient databases from the get-go. Most of the nutritive values of foodstuffs were borrowed from Indian nutrient databases.

Methodological differences were found between two databases while estimating energy-yielding nutrients. For example, dietary fibre and crude fibre were counted separately when available carbohydrates were calculated in FCTB-2012, whereas for FCTB-2013, dietary fibre and alcohol was taken into consideration for available carbohydrate calculation. But crude fibre and other indigestible carbohydrates were constituent of dietary fibre (Dai & Chau, 2017). Uses of various procedures to calculate available carbohydrates in nutrient databases could change the nutrient estimation of subjects (Hakala, Knuts, Vuorinen, Hammar, & Becker, 2003). Parboiled rice, the key source of carbohydrates and energy, is abundantly consumed in Bangladesh. Although a number of varieties of rice were reported in nutrient databases, only brown rice (parboiled and home-pounded) matched across both databases regarding name and sample description. About 5 g of carbohydrates was higher in FCTB-2012 (77.4 g/100 g) than in FCTB-2013 (72.4 g/100 g). Protein content was calculated by multiplying the nitrogen value in both databases, but the nitrogen conversion factors were not similar in both databases. Food-specific nitrogen conversion factors were used in FCTB-2013 when it was available; otherwise, FCTB-2013 used a fixed general conversion factor. But, FCTB-2012 mentioned about the methodological conversion factor without detailing any specific nitrogen conversion factor. Lentils are a common source of protein in rural and urban areas of Bangladesh. Almost 4 g in difference was found in 100-g lentil between FCTB-2012 and FCTB-2013 (23.91 g/100 g and 27.7 g/100 g, respectively). It might have an impactful influence on high consumption of protein estimations because of the influence of the food nitrogen factor on protein estimation (Mariotti, Tomé, & Mirand, 2008). Differences were found in fat estimation methods used. FCTB-2012 used separate methods for dried food and other raw food items, whereas FCTB-2013 applied one method to analyse key foods for fat estimations. In addition, foods were described in detail in FCTB-2013;

for instance, beef was counted as an individual food if it contained fat and as boneless and lean if without fat, whereas FCTB-2012 only reported beef without mentioning variations in the fat content. However, energy conversion factors were used to multiply macronutrients for calculating the energy value of the food in both databases. Although the estimated energy difference between the nutrient databases was low, variations in methodology of carbohydrates, protein, and fats could affect the observed differences in the total estimation of energy and energy-yielding nutrients.

Analytical methods used for estimating micronutrient content of the different foods were not the same in the two nutrient databases discussed. The greatest amounts of differences were found in beta-carotene, estimated differently in both databases. FCTB-2012 reported beta-carotene and alpha-carotene separately, whereas FCTB-2013 expressed beta-carotene as beta-carotene equivalent, which was a summation of beta-carotene, alpha-carotene, and beta-cryptoxanthin. This procedural difference had a big impact on the beta-carotene content of a food and also on the total beta-carotene estimation of a person's diet. Carrot is a prime source of beta-carotene. The quantity of beta-carotene contained within carrots was almost four times lower in FCTB-2012 (1,689.4 µg/100 g) than in FCTB-2013 (6,280 µg/100 g). What is more, two types of carrot (red and orange) were reported in the Indian FCT, and orange carrots contained two times more beta-carotene than did red carrots (5,423 µg/100 g and 2,706 µg/100 g, respectively) (Longvah, Anantan, Bhaskarachary, & Venkaiah, 2017). If one subject consumes 100 g of carrots daily, intake of beta-carotene would be four times higher according to FCTB-2013 than that according to FCTB-2012. Vitamin C was analysed using the same technique in both databases, but FCTB-2013 compared it with standard ascorbic acid. There were nearly 14 g of differences in vitamin C content of oranges between FCTB-2012 (40 mg/100 g) and FCTB-2013 (54 mg/100 g), whereas the Indian FCT reported 42.37 mg vitamin C per 100 g of orange, and that value was quite close to that in FCTB-2012. This difference could influence the total estimation of vitamin C and thus adequacy of intake of an individual. However, analytical methods of thiamin, riboflavin, niacin, vitamin B6, and folate were not mentioned in FCTB-2012. FCTB-2013 used different methods to analyse and to borrow minerals, whereas FCTB-2012 applied only one method to analyse the minerals.

Both nutrient databases borrowed nutrient information for most of the foods. FCTB-2012 had taken nutrient information from published and unpublished articles and laboratory reports and borrowed nutrient data from the English-version FCT of Bangladesh and the Indian FCT. A lot of micronutrient information was missing in FCTB-2012. However, FCTB-2013 compiled nutrient information from national and international FCTs, published and unpublished articles, and laboratory reports. Missing nutrients were filled out from different sources for the same food. FCTB-2013 also borrowed nutrient data from FCTB-2012 in some circumstances. In FCTB-2013, raw food, boiled food, and dried food were reported as separate foods, and detailed descriptions of sample foods were written in FCTB-2013.

FCTB-2013 reported more than 50 µg of folate in spinach, dark green leafy vegetable, and a rich source of folate when compared with FCTB-2012 (195 µg/100 g and 123 µg/100 g, respectively). None of the values of the Bangladesh FCTs were close to that of the Indian FCT (142 µg/100 g). These differences could lead to 129% median differences in folate intake, which might be a consequence of borrowing data from different sources or using diverse analytical methods for the same nutrient. Information on vitamin B6 was not available for most of the food in FCTB-2012; therefore, missing information was likely to lead 153% of the median difference between the nutrient databases. Although farm chicken eggs were analysed in both FCTs, zinc quantity in egg was almost two times higher in FCTB-2013 (2.36 mg/100 g) than in FCTB-2012 (1.171 mg/100 g), and only the zinc value of FCTB-2012 was close to that of the Indian FCT (1.23 mg/100 g). Catla fish contained 0.3 mg higher iron in FCTB-2012 (0.9 mg/100 g) than in FCTB-2013 (0.6 mg/100 g), but the Indian nutrient database reported higher iron (1.14 mg/100 g) than that in Bangladeshi FCTs. Missing values were found for thiamin, riboflavin, niacin, and other minerals in FCTB-2012. A missing value or zero value could introduce errors related to nutrient adequacy in food consumption survey (National Research Council, 1986). Furthermore, borrowing nutrient information from different sources to fill out the missing values or to replace old values had noticeable impact on nutrient intakes (Anderson, Perloff, & Ahuja, 2001). Variation in analytical methods used to estimate the same nutrients and nutrient data gathered from nonoutlined sources may not be comparable (Deharveng et al., 1999). This study had some limitations. This study used HIES data for assessing the divergence and agreement on nutrient intakes. Since the HIES collects dietary data in across 14 consecutive days using seven visits by the enumerators to each household every 2 days, this study might have some recall bias. Additionally, the HIES do not provide intrahousehold food distribution patterns, limiting disaggregated analysis of nutrient intake based on age, sex, and physiological status.

5 | CONCLUSIONS

In summary, statistically significant differences were found in median intakes of all examined nutrients except for niacin and phosphorous. Median intakes of vitamin C, beta-carotene, vitamin B6, folate, and zinc had displayed substantial differences. Correlation coefficients were good for most of the nutrients, but only energy and carbohydrates showed excellent agreement. More than 15% of the subjects were misclassified and found in extreme opposite quintiles for beta-carotene, vitamin B6, folate, copper, and sodium. Variations in analysis methodologies regarding nutrients and differences in sources of borrowed nutrient information were the major factors for observed differences in nutrient intakes. The results of this study clearly indicate that there are concerning differences in the two FCTs that might influence food and nutrition related policies, programmes, and research studies in Bangladesh. A review of the FCTs with a special focus on micronutrient contents is vital for having a reliable and valid

FCT for Bangladesh. More original research on a variety of nutrients of Bangladeshi food items and collaboration with different food and nutrition-related agencies are required for an updated FCT for the Bangladeshi population.

ACKNOWLEDGMENTS

We are grateful to Nancy-Jane Bulfin who reviewed the manuscript and provided us valuable feedback.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICAL STATEMENT

This study was a secondary analysis of de-identified data; thus, no ethical permission is required.

CONTRIBUTIONS

MRA initiated the concept. MA and MRA both designed and analysed the data. MA wrote the first draft. MRA reviewed and edited the manuscript.

ORCID

Masum Ali  <https://orcid.org/0000-0003-3988-8038>

Md Ruhul Amin  <https://orcid.org/0000-0002-4252-5804>

REFERENCES

- Ahuja, J. K., Goldman, J. D., & Perloff, B. P. (2006). The effect of improved food composition data on intake estimates in the United States of America. *Journal of Food Composition and Analysis*, 19, S7–S13. <https://doi.org/10.1016/j.jfca.2005.12.007>
- Al Hasan, S. M., Hassan, M., Saha, S., Islam, M., Billah, M., & Islam, S. (2016). Dietary phytate intake inhibits the bioavailability of iron and calcium in the diets of pregnant women in rural Bangladesh: A cross-sectional study. *BMC Nutrition*, 2, 24. <https://doi.org/10.1186/s40795-016-0064-8>
- Ali, S. M. K., & Pramanik, M. M. A. (1991). *Conversion factors and dietary calculations*. Dhaka Bangladesh: Institute of Nutrition and Food Science, University of Dhaka.
- Anderson, E., Perloff, B., Ahuja, J.K.C. (2001). Tracking nutrient changes for trends analysis in th United States. *Journal of Food Composition and Analysis*, 14, 287–294. DOI: 10.006/jfca.2001.0993
- Bell, S., Becker, W., Vásquez-Cacedo, A. L., Hartmann, B. M., Møller, A., & Butriss, J. (2006). Report on nutrient losses and gains factors used in European food composition databases. *European Food Information Resource Network*.
- Bermudez, O. I., Lividini, K., Smits, M. F., & Fiedler, J. L. (2012). Estimating micronutrient intakes from Household Consumption and Expenditures Surveys (HCES): an example from Bangladesh. *Food and nutrition bulletin*, 33, S208–S213. <https://doi.org/10.1177/156482651203335209>
- Campbell, R. K., Hurley, K. M., Shamim, A. A., Shaikh, S., Chowdhury, Z. T., Mehra, S., ... Christian, P. (2018). Complementary Food Supplements Increase Dietary Nutrient Adequacy and Do Not Replace Home Food Consumption in Children 6–18 Months Old in a Randomized Controlled Trial in Rural Bangladesh. *The Journal of nutrition*, 148, 1484–1492. <https://doi.org/10.1093/jn/nxy136>
- Dai, F. J., & Chau, C. F. (2017). Classification and regulatory perspectives of dietary fiber. *Journal of Food and Drug Analysis*, 25, 37–42. <https://doi.org/10.1016/j.jfda.2016.09.006>

- Darnton-Hill, I., Hasan, N., Karim, R., & Duthie, M. R. (1988). *Tables of nutrient composition of Bangladesh foods; English version with particular emphasis on vitamin A content*. Dhaka: HKI and WFP.
- Deharveng, G., Charrondiere, U. R., Slimani, N., Southgate, D. A. T., & Riboli, E. (1999). Comparison of nutrients in the food composition tables available in the nine European countries participating in EPIC. *European Journal of Clinical Nutrition*, 53, 60–79. <https://doi.org/10.1038/sj.ejcn.1600677>
- Deptford, A., Allieri, T., Childs, R., Damu, C., Ferguson, E., Hilton, J., ... Hall, A. (2017). Cost of the Diet: A method and software to calculate the lowest cost of meeting recommended intakes of energy and nutrients from local foods. *BMC Nutrition*, 3, 26. <https://doi.org/10.1186/s40795-017-0136-4>
- Elmadfa, I., & Meyer, A. L. (2010). Importance of food composition data to nutrition and public health. *European journal of clinical nutrition*, 64, S4–S7. <https://doi.org/10.1038/ejcn.2010.202>
- Hakala, P., Knuts, L. R., Vuorinen, A., Hammar, N., & Becker, W. (2003). Comparison of nutrient intake data calculated on the basis of two different databases. Results and experiences from a Swedish–Finnish study. *European Journal of Clinical Nutrition*, 57, 1035–1044. <https://doi.org/10.1038/sj.ejcn.1601639>
- Harris-Fry, H., Beard, B. J., Harrison, T., Paudel, P., Shrestha, N., Jha, S., ... Saville, N. M. (2018). Smartphone tool to collect repeated 24 h dietary recall data in Nepal. *Public Health Nutrition*, 21, 260–272. <https://doi.org/10.1017/S136898001700204X> Epub 2017 Aug 31
- Hels, O., Kidmose, U., Larsen, T., Hassan, N., Tetens, I., & Haraksingh Thilsted, S. (2003). Estimated nutrient intakes and adequacies in Bangladesh change when newer values for vitamin A, iron and calcium in commonly consumed foods are applied. *International Journal of Food Sciences and Nutrition*, 54, 457–465. <https://doi.org/10.1080/09637480310001622314>
- Institute of Nutrition and Food Science (1977). *Nutritive values of local foodstuffs*. Dhaka, Bangladesh.
- Institute of Public Health Nutrition (1979). *Nutritive values of different foods in Bangladesh*. Dhaka, Bangladesh.
- Islam, S. N., Khan, M. N. I., & Akhtaruzzaman, M. (2012). *Food composition tables and database for Bangladesh with special reference to selected ethnic foods*. Dhaka: Institute of Nutrition and Food Science, University of Dhaka.
- Lantz, B. (2013). The large sample size fallacy. *Scandinavian Journal of Caring Sciences*, 27(2), 487–492. <https://doi.org/10.1111/j.1471-6712.2012.01052.x>
- Leclercq, C., Valsta, L. M., & Turrini, A. (2001). Food composition issues—Implications for the development of food-based dietary guidelines. *Public Health Nutrition*, 4, 677–682. <https://doi.org/10.1079/PHN2001153>
- Longvah, T., Anantan, I., Bhaskarachary, K., & Venkaiah, K. (2017). *Indian food composition tables*. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research.
- Mariotti, F., Tomé, D., & Mirand, P. P. (2008). Converting nitrogen into protein—Beyond 6.25 and Jones' factors. *Critical Reviews in Food Science and Nutrition*, 48, 177–184. <https://doi.org/10.1080/10408390701279749>
- National Research Council (1986). *Nutrient adequacy: Assessment using food consumption surveys*. National Academies Press. Retrieved from <http://www.nap.edu/catalog/618.html>
- Rahman, S., Ahmed, T., Rahman, A. S., Alam, N., Ahmed, A. S., Ireen, S., ... Rahman, S. M. (2016). Status of zinc nutrition in Bangladesh: The underlying associations. *Journal of Nutritional Science*, 5, e25, 1–9. <https://doi.org/10.1017/jns.2016.17>
- Rahman, S., Rahman, A. S., Alam, N., Ahmed, A. S., Ireen, S., Chowdhury, I. A., ... Ahmed, T. (2017). Vitamin A deficiency and determinants of vitamin A status in Bangladeshi children and women: findings of a national survey. *Public health nutrition*, 20, 1114–1125. <https://doi.org/10.1017/S1368980016003049>
- Schönfeldt, H. C., & Gibson, N. (2010). Food composition data in health communication. *European Journal of Clinical Nutrition*, 64, S128–S133. <https://doi.org/10.1038/ejcn.2010.223>
- Shaheen, N., Rahim, A. T. M. R., Mohiduzzaman, M., Banu, C. P., Bari, M. L., Tukun, A. B., Mannan, M., Bhattacharjee, L. & Stadlmayr, B. (2013). Food composition for Bangladesh.
- Waid, J. L., Sinharoy, S. S., Ali, M., Stormer, A. E., Thilsted, S. H., & Gabrysch, S. (2018). Dietary patterns and determinants of changing diets in Bangladesh from 1985 to 2010. *Current Developments in Nutrition*, 3(4), nzy091
- Yamini, S., Juan, W., Marcoe, K., & Britten, P. (2006). Impact of using updated food consumption and composition data on selected MyPyramid food group nutrient profiles. *Journal of Nutrition Education and Behavior*, 38, S136–S142. <https://doi.org/10.1016/j.jneb.2006.08.003>

How to cite this article: Ali M, Amin MR. Divergence and agreement on nutrient intake between the two food composition tables of Bangladesh. *Matern Child Nutr.* 2020;16 (S3):e12940. <https://doi.org/10.1111/mcn.12940>