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Letter to the Editor

Mineral Intake in Urban Pregnant Women from Base Diet, Fortified Foods, and Food Supplements: Focus on Calcium, Iron, and Zinc*

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In the Chinese national nutrition surveys, fortified foods were not investigated separately from the base diet, and the contribution of fortified foods to micronutrients intake is not very clear. This study investigated the diet, including fortified foods and food supplements, of urban pregnant women and analyzed the intake of calcium, iron, and zinc to assess the corresponding contributions of fortified foods, food supplements, and the base diet. The results demonstrated that the base diet was the major source of calcium, iron, and zinc, and was recommended to be the first choice for micronutrients intake. Furthermore, consumption of fortified foods and food supplements offered effective approaches to improve the dietary intake of calcium, iron, and zinc in Chinese urban pregnant women.

Key words: Mineral intake; Base diet; Fortified food; Food Supplements

The Rome Declaration on Nutrition in 2014 reported that over two billion people in the world experience deficiencies of micronutrients, in particular vitamin A, iodine, iron, and zinc[1], a view that was also mentioned in published guidelines on food fortification with micronutrients[2]. Chinese national nutrition surveys up to 2010 showed that the intake of calcium, iron, vitamin A, and folate in pregnant women was under the recommended intake level[3]. The strategies for the control of micronutrient malnutrition recommended by Food Agricultural Organization of the United Nations and the World Health Organization including food-based approaches such as dietary diversification and food fortification, nutrition education, public health and food safety measures, and food supplementation[2]. All of these strategies can be applied to prevent nutrient deficiencies, especially in women and children.

In China, with the continuous improvement of the food fortification standards, the National Food Safety Standard GB14880-2012, a standard for the use of nutritional fortification substances in foods[4], has been published and enforced. Various domestic or imported fortified products are introduced in the markets, which are communized to improve micronutrients intake for whom experiencing deficiencies. This standard permitted voluntary micronutrients fortification in some food categories such as dairy products, cereal products, and beverages. Following this standard, food for pregnant and lactating women can be fortified with micronutrients to give specific nutritional support[5]. A large number of pregnant women consume fortified foods such as pregnancy milk powder and they are also the primary consumers of food supplements. Calcium, iron, and zinc are common micronutrients fortified in pre-packaged foods and are often the ingredients of food supplements; therefore, the total intake of these three minerals along with the effects of fortification and food supplementation are a concern. However, since fortified foods were not investigated separately from the base diet in the national nutrition surveys, the contribution of fortified foods to micronutrients intake has not been reported. Therefore, the separate contributions of the base diet, fortified foods, and food supplements to the total intake of micronutrients should be evaluated, and the benefits and risks of fortified foods and food supplements should also be considered in order to provide references for reevaluating or revising relevant standards or regulations.

A survey was conducted on the dietary data in terms of the base diet and consumption of fortified foods and food supplements of urban pregnant women as well as demographic information and

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awareness of fortified foods and food supplements. The survey was aimed to identify the contributions of major minerals from the three sources and to conduct a preliminary evaluation of the benefits and risks of fortified foods and food supplements.

In this study, 298 mid-trimester urban pregnant women at the survey sites (Beijing in Northern China, Hefei in middle China, and Nanning in Southern China) were included. The food composition data used in this study were obtained from the Chinese Food Composition Table[6], and another database of the fortified foods and food supplements was built based on the product labels, so that the total intake of these three minerals could be calculated and compared with the Chinese dietary reference intake (DRI) values. The recommended nutrient intake (RNI) and tolerable upper intake level (UL) were used as cutoff points to estimate the prevalence of inadequate intake and the risk of excessive intake, respectively. The differences in nutrients intake before and after consuming fortified foods and food supplements were analyzed by Wilcoxon signed-rank test to determine the contribution of fortified foods and food supplements. A P value < 0.05 was considered statistically significant.

Most (81.54%) of the pregnant volunteers in this study were between 25 and 35 years of age. Their approximate per capita monthly income was ¥2,000-10,000, and monthly expenditure on food was ¥500-2,000 per subject. Their gestational age was 23.17 ± 3.88 weeks, and the majority (83.6%) were experiencing their first pregnancy. Anemia and systremma occurred in 6.12% and 46.64%, respectively. Awareness of fortified foods was 76.85%, approximately 22% lower than that of food supplements. The percentages of subjects who are very familiar with fortified foods and food supplements were both at low levels. Approximately 52.01% (155/298) of the subjects had consumed fortified foods during the past week (more than three times), mainly milk (29.87%) and milk powder (27.52%) and 71.14% (212/298) of the subjects had consumed food supplements during the past month (following the product instructions). Multivitamins and minerals were the main types of food supplements consumed (81.60%), with some consumption also of single minerals or vitamins.

Figure 1 shows that the base diet was the greatest contributor to the total intake of calcium, iron, and zinc (with an average contribution of 68.99%, 85.97%, and 80.57%, respectively), followed by food supplements (20.88%, 10.05%, and 15.39%, respectively), whereas fortified foods contributed the least (10.13%, 3.98%, and 4.04%, respectively). Some researches in other countries showed that fortified foods can play a certain role in improving nutritional status, whereas others reported adverse results[7-9]. In this study, to some extent, the contributions of fortified foods to mineral intake and the average contribution differed from results reported by European or other countries[7-9] as well as some Chinese data[10]. For instance, in this research, the contribution of calcium from fortified foods is higher than the result in Irish female adults (3.6%)[7], whereas the results for iron are lower. This may due to factors such as the different dietary models, fortification levels or scopes.

To address concerns about excess nutrients intake, the percentiles of calcium, iron, and zinc intake were calculated with/without fortified foods and food supplements and were compared with the latest Chinese DRIs. The results showed that fortified foods and food supplements increased the total intake of these three minerals. The median of calcium intake increased from 1058.99 mg to 1210.89 mg when fortified foods were added, and more obvious increases were found for food supplements. The percentage of adequate intake also increased significantly (P < 0.01) (Table 1). The distribution of calcium, iron, and zinc intake in comparison with DRIs showed that for calcium, suitable intake (intake level between RNI and UL) increased by 18.45% and

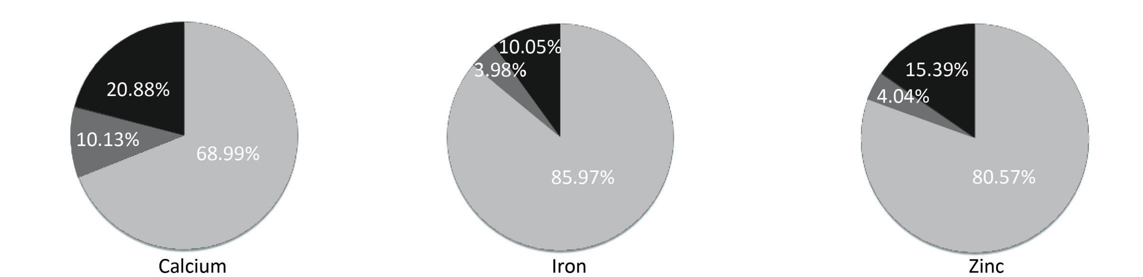

Figure 1. Average contribution of different sources to the intake of calcium, iron, and zinc.

6.71% after the consumption of food supplements and fortified foods, respectively (Figure 2). However, for iron, owing to the increased number of subjects with an intake over the UL value, suitable intake decreased by 4% after the addition of food supplements. As discussed above, fortified foods and food supplements can play an important role in improving the status of mineral intake of the population. The contribution of food supplements is higher than that of fortified foods but much lower than that of the base diet. For some individuals, there is an increased risk of excess intake, especially for iron, because of the high concentration found in food supplements. When subjects consume both fortified foods and food supplements, the proportion that exceeds the UL value apparently increases, especially for calcium. Therefore, more guidance for the use of fortified foods and food supplements is suggested.

In summary, the base diet was the main source

Table 1. Percentiles of Calcium, Iron, and Zinc Intake before/after Addition of Fortified Foods and Food Supplements

Minerals	Sources	P50	P95	RNI	UL
Calcium (mg)	TOTAL	1210.89[a1]	2287.40	1000	2000
	TOTAL-FF	1058.99[a2]	1982.89		
	TOTAL-FS	857.40[a3]	1830.84		
Iron (mg)	TOTAL	33.00[b1]	77.85	24	42
	TOTAL-FF	31.36[b2]	75.96		
	TOTAL-FS	28.10[b3]	60.66		
Zinc (mg)	TOTAL	17.78[c1]	36.22	9.5	40
	TOTAL-FF	16.97[c2]	35.42		
	TOTAL-FS	14.02[c3]	27.82		

Note. BD, base diet; FF, fortified foods; FS, food supplements; RNI, recommended nutrient intake; UL, tolerable upper intake level. TOTAL = BD + FF + FS, TOTAL – FF = BD + FS, TOTAL – FS = BD + FF. Superscript letter–number combinations indicate significant differences: [a1] compared with [a2], Z = -10.62, P < 0.01; [a1] compared with [a3], Z = -12.00, P < 0.01; [a2] compared with [a3], Z = -6.15, P < 0.01; [b1] compared with [b2], Z = -8.64, P < 0.01; [b1] compared with [b3], Z = -8.61, P < 0.01; [b2] compared with [b3], Z = -2.79, P < 0.01; [c1] compared with [c2], Z = -8.64, P < 0.01; [c1] compared with [c3], Z = -8.78, P < 0.01; [c2] compared with [c3], Z = -6.63, P < 0.01.

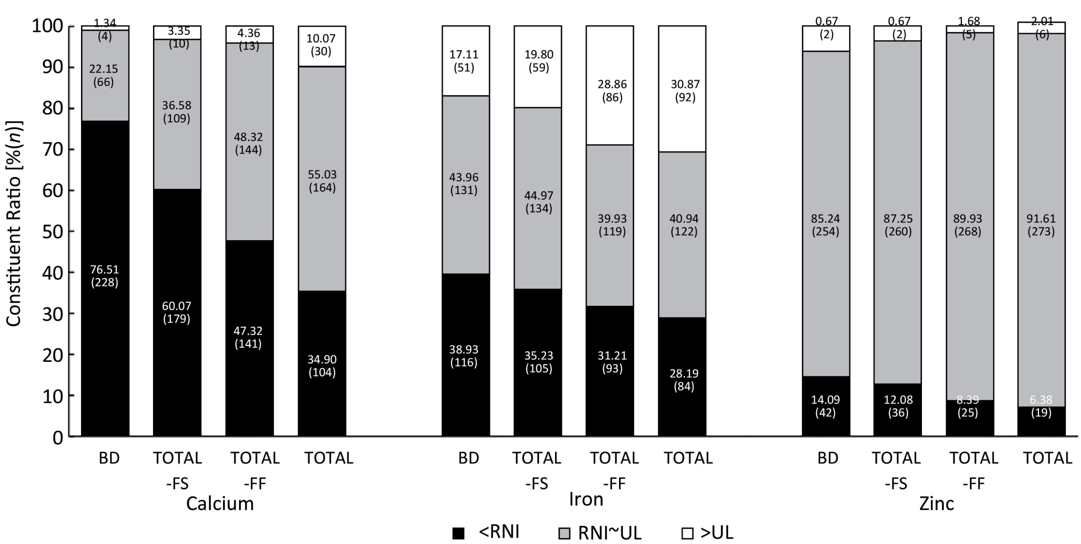

Figure 2. Distribution of calcium, iron, and zinc intake in comparison with dietary reference intake values. BD, base diet; FF, fortified foods; FS, food supplements; RNI, recommended nutrient intake; UL, tolerable upper intake level.

of calcium, iron, and zinc in urban pregnant women, which was recommended to be the first choice for nutrients intake. Meanwhile, for urban pregnant women, consumption of fortified foods and food supplements can be an effective approach to improve the minerals intake when a calcium, iron, or zinc deficiency is encountered. However, the contribution of fortified foods for these three nutrients was still at a rather low level, indicating that the fortified values of GB 14880-2012 can be higher, based on more risk analysis data. For example, more micronutrients need to be evaluated, and the database of fortified foods needs to be improved. Meanwhile, further intensive studies concerning nutrients risk assessment re-assessment and risk-benefit analysis of fortification is required.

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