Original Article

The contribution of milks and formulae to micronutrient intake in 1-3 years old children in urban China: a simulation study

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Background and Objectives: A recent dietary survey in 5 big cities in China provided information on various milk options consumed by 1-3 years old children. To investigate the nutritional role of these milks (young-child formula (YCF), cow's milk, others), simulation analyses based on this survey were performed. **Methods and Study Design:** We studied daily intakes of calcium, iron, zinc, vitamins A, B-1, B-2, C and E and compared these to the Chinese DRIs. In Scenario 1, consumption of cow's milk, kid's milk and/or soy milk was replaced with matching amounts of YCF (n=66 children). In Scenario 2, where 348 children exclusively consumed YCF, YCF was replaced with matching amounts of cow's milk. **Results:** Scenario 1 revealed significant increases in total dietary intakes of iron, vitamins A, B-1, C and E upon substitution of the various milks with YCF. The proportions of children not meeting the Estimated Average Requirement (EAR) for these nutrients dropped from 29, 26, 61, 53 and 54 % to 12, 11, 50, 27 and 24%, respectively. In Scenario 2, the hypothetical substitution of YCF by cow's milk increased the proportions of children not meeting the EAR for these nutrients, calcium and zinc from 11, 6, 49, 15, 28, 42, and 8 to 45, 24, 78, 69, 59, 44, and 20, respectively. Execution of Scenario 2 in subgroups of 1-2- and 2-3 years old children revealed similar results. **Conclusions:** YCF may help to reduce the risk of insufficient intake of several key micronutrients for toddlers, independent of age.

Key Words: nutrition, young-children, formula, cow's milk, dietary intake

INTRODUCTION

During the first three years of age, children have high nutritional requirements to support the rapid growth and development of the body. The period of 1-3 years is also critical because of the gradual increase in diet variety: from breastmilk to complementary and many other types of foods and drinks. This transition is often associated with an increased risk of suboptimal macro- and micronutrients intake, particularly in less developed countries or regions.[1] Stunting and wasting rates of young-children in China showed an impressive decrease in recent decades. Nevertheless, micronutrient deficiencies have been reported in both national and local studies. The 2002 national report on development and health of infants and toddlers (0-6 years) indicated that the average vitamin A intake at 2-3 years of age was only 14% of Chinese Recommended Nutrient Intakes (RNIs), and calcium intake was about 33% of Average Intakes (AI), which was even worse in urban area compared to rural area.[2] Zinc deficiency was found in 25-35% of young children, according to serum zinc analysis.[3]

Cow's milk is one of the most often consumed dairy products by young children worldwide. It provides critical nutrients like protein, fat and calcium that are essential for growth and development. However, increased risks of insufficient intakes of essential fatty acids, iron, and vitamins C and D were reported in French children consuming non-fortified cow's milk.[4] This contributed to debating the need for modifications in young children's diet and/or use of nutritional supplements or nutrient fortified products. According to a recent European Food Safety Authority (EFSA) recommendation, young-child formula (YCF, formula fortified with a range of key nutrients required by toddlers also referred to as Growing Up Milk (GUM)) is one of several tools to help reach adequate intakes of critical nutrients in young children.[5] The ESPGHAN Committee on Nutrition recently issued a

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similar position based on a critical literature review.[6] Although they indicated that based on the existing evidence, there is no need for routine use of YCF in 1-3 years old children in Europe, they made a plea for regulation of YCF to avoid inappropriate composition. They also suggested that if YCF is considered as a substitute for cow's milk, a simpler composition may be proposed, e.g. fortified with only a few key nutrients like iron, vitamin D and n-3 PUFA. In China, the Nutrition Society recommended breast feeding until the age of 2 years old and above, or 500 ml/day of YCF for 1-2 years old young children who are not breast fed, while the consumption of fresh milk, milk powder for adults or soy protein powder-based milks were not specified as preferred options.[7] Studies on the role of YCF in young children's diets are limited. A recent study found positive relationships between YCF intake and intakes of essential fatty acids, vitamins E, C and D in 1-2 years old French children.[4] A 20-weeks intervention study in Western Europe comparing YCF with cow's milk revealed that YCF was able to reduce the prevalence of vitamin D deficiency, assessed by 25-hydroxy vitamin D analyses, from 25 to 14%, and keep the prevalence of iron deficiency, assessed by ferritin analysis, constant at around 14%; in the cow's milk group the prevalence of both micronutrient deficiencies increased from 22 to 33% and from 12 to 30%, respectively.[8] Similar results have been reported in a recent New Zealand and Australian study comparing YCF with cow's milk in 1-2 years old children after an intervention period of 12 months.[9] Apart from cow's milk, also soya milk (exclusively made out of soya beans according to Chinese tradition with no nutrients fortification) and kid's milk (cow's milk fortified with limited nutrients) are popular among Chinese young children. To our knowledge, scientific studies comparing the nutritional adequacy of diets including YCF, kid's milk and/or soya milk against the background of the current diet in Chinese young children have not yet been performed.

In this study we have used data from a recent dietary survey done in 5 big cities in China where 78% of the 1-3 years old children obtained YCF.[10,11] Simulation techniques were employed to investigate the effects of substitution of either non-YCF milks by YCF, or by replacing YCF with cow's milk without changing the other parts of the diet. We report on actual and simulated intakes of calcium, iron, zinc and vitamins A, B-1, B-2, C and E.

METHODS

Subjects

The study data were selected from the data obtained from a dietary survey in 6-36 months old children done in 2012 in Beijing, Shanghai, Shenzhen, Chengdu and Nanjing.[9,10] Children aged 1-3 years who did not consume YCF or any other type of milk (cow's milk, soya milk and kid's milk) (n=45), those who were still fed breast milk (n=34), and those who exclusively consumed goat (n=4) or soya milk (n=3) were all excluded; exclusive goat milk and soya milk users were excluded as they might follow a special diet due to (perceived) allergies. Subsequently, 414 out of the 500 children aged between 1 and 3 years from the original dietary survey were selected for the current study. According to the intake of YCF and the various other milks studied, two groups were formed: Group 1: milks users with or without of YCF consumption (if YCF was used, it was always combined with other milks; n=66) and Group 2: YCF-only users (n=348).

Study scenarios

Suitable scenarios for each group were defined to run deterministic simulation analyses. In Scenario 1, cow's milk, kid's milk and soya milk intakes in young children from Group 1 were replaced with matching amounts of a commercial YCF product (Dumex DiamorTM; stage: 1-3 years) (n=66); for the children in this group who consume YCF together with other milks, the amount of YCF, matched with the amount of other milks consumed was topped up with original YCF contribution. In Scenario 2 in young children consuming only YCF, YCF was replaced with matching amounts of cow's milk (Group 2, n=348); cow's milk was the second most frequently consumed milk after YCF in 1-3 years old children. Within Scenario 2, we also assessed for possible differences between 1-2 years (n=180) and 2-3 years old children (n=168). The design of the study is illustrated in Figure 1.

Because the dry powder weight of YCF was recorded in the dietary survey, while other milks were quantified as ready to drink volumes, we used an amount of 18 g of formula powder to be equivalent to 100 mL of YCF for consumption, based on the formula serving instructions.

Data analysis and nutritional composition of simulation products

Total dietary intakes (median, Q1, Q3) of micronutrients (vitamins A, B-1, B-2, C and E, calcium, iron and zinc) for the subjects selected for this study were calculated from the data set of the original study.[11] The micronutrient compositions of cow's milk and soya milk were taken from the Chinese Food Composition Table,[12] and we used current commercial brand information for the composition of kid's milk (Yili QQ StarTM), and of the YCF studied (Dumex DiamorTM, stage of 1-3 years) (Table 1). All simulation analyses were performed using the software "Creme Food" (Creme Global Ltd., Dublin, Ireland) as described earlier.[13] Nutritional adequacy was evaluated by comparing observed dietary intakes to the Estimated Average Requirement (EAR), provided as part of the Chinese Daily Recommended Intakes (DRIs) (2013). This edition of the Chinese DRIs was based on extensive reviews of both Chinese and international literature. For children aged >1 yr, EARs were calculated based on adult data, taking into considerations body weight and requirements for growth of young children.[14] Intakes lower than the EAR were described as potentially inadequate. The percentages of children having intakes below the EAR for each of the selected nutrients were calculated. Comparisons between groups on percentages of children not meeting EAR were done using Chi-square testing. Comparisons between Groups 1 and 2 on food group consumption or nutrient intake levels were done applying Wilcoxon rank-sum tests. Nutrient intakes before and after simulation were compared using paired Wilcoxon signed-rank testing. The effect of substitution on the percentage of subjects not meeting EAR for selected nutrients was verified using McNemar's test for correlated proportions. The

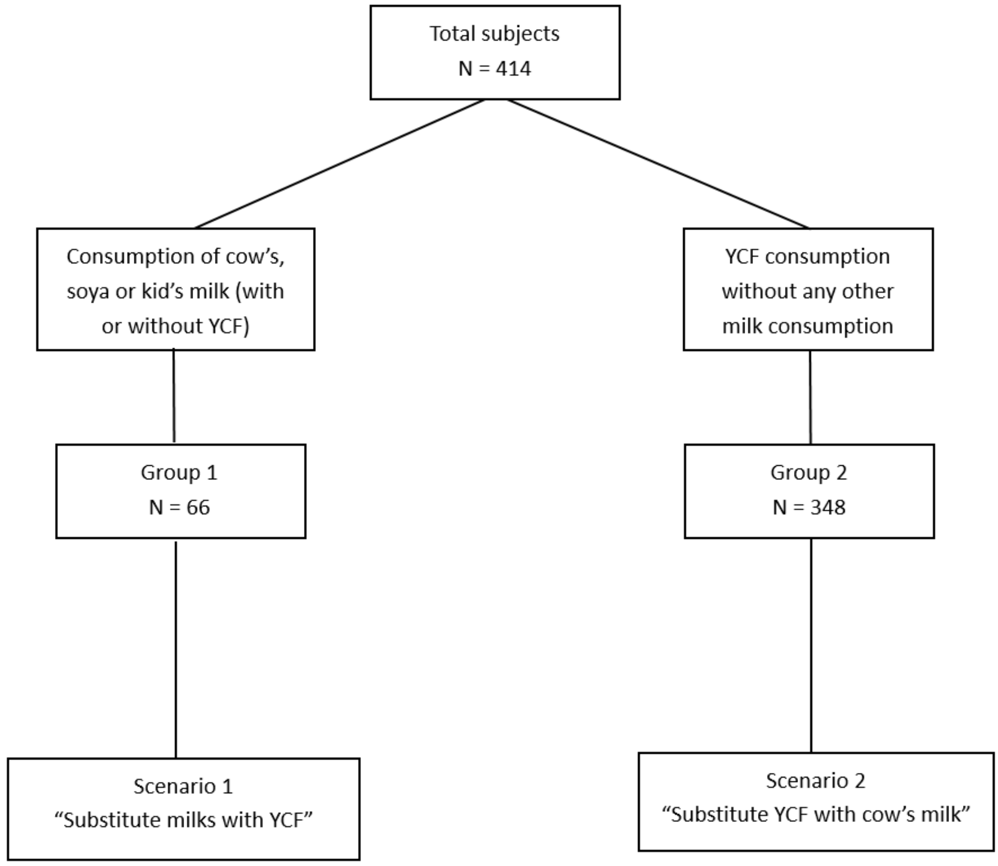

Figure 1. Simulation study design

Table 1. Nutritional composition per 100 mL of cow's milk, young-child formula, kid's milk and traditional soya milk used for the simulation analyses

	Cow's milk†	YCF‡	Kid's milk§	Traditional Soya milk†
Calcium (mg)	104	112	110	10
Iron (mg)	0.3	1.2	0	0.5
Zinc (mg)	0.4	0.5	0.4	0.2
Vitamin A (μg-RAE)	24	78.3	31.2	15
Vitamin B-1 (mg)	0.03	0.7	0.0	0.0
Vitamin B-2 (mg)	0.1	1.2	0.13	0.0
Vitamin C (mg)	1	12.2	22.7	0
Vitamin E (mgα-TE)	0.2	0.7	0	0.8

YCF: young-child formula.
†Chinese Food Composition Table (Yang, et al., 2009) (data given per 100 g).
‡Dumex DiamorTM (stage for age 1-3 years).
§Yili QQ StarTM.

level of significance was set at $p<0.05$ and where appropriate, testing was done two-sided.

RESULTS

Population description and nutrient intakes before simulation

In the 414 included children, average YCF consumption amounted to 96.2 g/day (~535 mL/day) in YCF-only subjects (n=348, Group 2) and 42.3 g/day (~235 mL/day) in subjects who reported consumption of YCF together with other milks (n=41, part of Group 1). Average cow's milk consumption in the children with reported cow's milk use was 278 mL/day (n=39 children, part of Group 1). Average intakes of kid's milk and soya milk amongst the consumers of these kinds of milk were 174 and 119 mL/day respectively (n=16 and 15 children, respectively, both part of Group 1).

The food group consumption patterns of the included children in Groups 1 and 2 according to ages 1-2 years and 2-3 years are presented in Table 2a. In both age groups, more than 60% of the children consumed grains/tuber/crops, vegetables, fruits, eggs and formula, while beans including tofu were introduced rather late in the diet of the young children. In the 1-2 years old children in the various milks users (Group 1), the median intake level of vegetables was lower and that of eggs was higher compared to the YCF-only users (Group 2), but this was not statistically significant probably because of the small sample size of Group 1. In the 2-3 years old children, the median intake levels of vegetables and fruits

Table 2a. Food groups consumption (g) assessed by 24 hr. recall in 1-2- and 2-3 years old children according to milks and formula use

	12-23 months old					24-35 months old				
	Group 1 (n=18)		Group 2 (n=180)		China dietary	Group 1 (n=48)		Group 2 (n=168)		China dietary
	Median (Q1,Q3)	%-use	Median (Q1,Q3)	%-use	Recommendation[7]	Median (Q1,Q3)	%-use	Median (Q1,Q3)	%-use	Recommendation[7]
Grains, tuber, crops	136.5 (65, 275)	100	150 (66.5, 277.5)	97.2	50-100 g	182.5 (90, 270)	100	176 (70, 278)	96.4	85-100 g
Vegetables	12.8 (0, 46.9)	72.2	24.3 (5.13, 46.9)	77.8	N.S.	27.8 (13, 84.9)	85.4	43.6 (19, 90.5)	89.9	200-250 g
Fruits	45.2 (0, 92.1)	72.2	45 (2.3, 119.6)	75.6	N.S.	37.7 (15.6, 101)	79.2	61.6 (13.5, 146)	79.2	100-150 g
Beans, tofu	0 (0, 100)	33.3	0 (0, 0)	23.9	N.S.	7.8 (0, 43.1)	56.3	0 (0, 14.9)*	34.5	N.S.
Meat, fish, poultry	22.5 (0, 45)	72.2	17.2 (0.5, 38.5)	75	50-75 g	20 (5, 39.2)	77.1	23.5 (5, 46.5)	78	50-70 g (in total)
Eggs	41.1 (0, 43.5)	72.2	27.2 (0, 48.7)	74.4	1 egg (~50 g)	37.2 (4.4, 52.2)	75	40.9 (8.8, 50.8)	79.8	
Milk, dairy†	200 (5, 240)	100	0 (0, 0)*	0	N.S.	155 (120, 250)	100	0 (0, 0)*	0	300-400 mL
Formula ‡	167 (0, 475)	66.7	426 (296, 657)*	100	500 mL	167 (0, 314)	60.4	325 (219, 450)*	100	

†Also includes "kid's milk" and soya "milk".
‡Reconstituted, ready to drink according to manufacturer's instruction. 18g ->100 ml.
*Significantly different between Groups 1 and 2 (p<0.05; Wilcoxon rank sum test).

Table 2b. Percentage of 1-2- and 2-3 years old children with nutrient intake below EAR in the two groups of users, based on milk and/or YCF consumption

	Percentage of children with intake <EAR†			
	12-23 months old		24-35 months old	
	Group 1 (n=18)	Group 2 (n=180)	Group 1 (n=48)	Group 2 (n=168)
Calcium	44.4	38.9	52.1	45.2
Iron	33.3	10.6*	27.1	10.7*
Zinc	16.7	8.3	18.8	7.7*
Vitamin A	27.8	6.7*	25	4.8*
Vitamin B-1	55.6	46.7	62.5	50.6
Vitamin B-2	16.7	6.1	18.8	6.0*
Vitamin C	38.9	14.4*	58.3	15.5*
Vitamin E	50	31.1	56.3	25.6*

EAR: Estimated Average Requirement; YCF: young-child formula.
*Significantly different between Group 1 and Group 2 (p<0.05; Chi-square test).

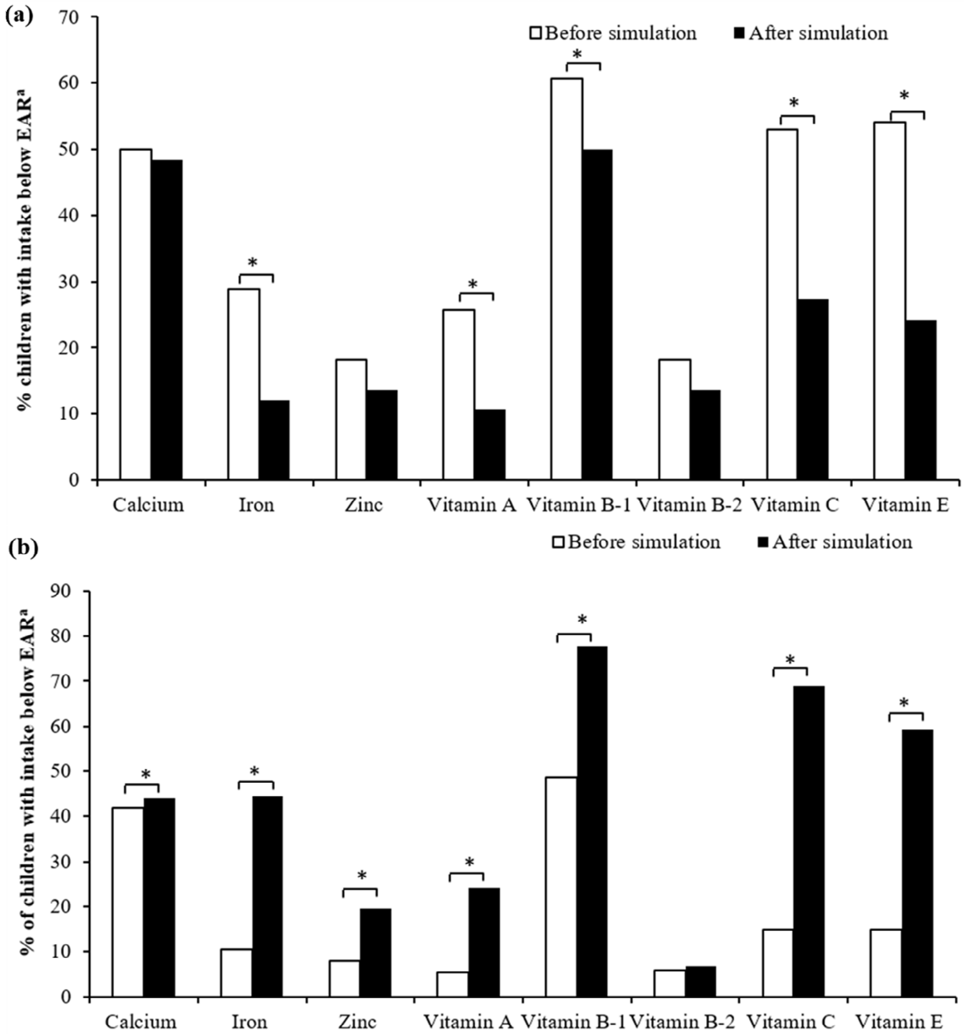

Figure 2. (a) Percentage of children with nutrient intake below EAR before and after simulation in Scenario 1 (replacing milks with matching amount of YCF in children consuming various milks; n=66). (b) Percentage of children with nutrient intake below EAR before and after simulation in Scenario 2 (replacing original YCF with matching amount of cow's milk in exclusive YCF users; n=348). *Significantly different before and after simulation ($p<0.05$; McNemar's test)

in Group 2 were nearly twice as high compared to the subjects in Group 1, which nearly reached significance ($p=0.07$) for fruits (Table 2a). The significant differences in terms of formula and milk/dairy products intakes in Group 1 and Group 2 were inherent to the selection of YCF-only vs various milk users. For the food group beans, including tofu, the difference in intake levels between Group 1 and Group 2 was statistically significant in the 2-3 years old subjects ($p<0.05$).

In Table 2b, micronutrient intakes of 1-2- and 2-3 years old children in Groups 1 and 2 were compared to the Chinese EAR. Except for the proportion of subjects with vitamin B-1 intake below the EAR in group 1, at least 50% of all studied 1-2 years old children had nutrient intakes above the EAR, suggesting adequate intake at a population level. For the 2-3 years old children in group 1, more than 50% of the children did not reach the EAR for calcium, vitamins B-1, C and E in Group 1, while in group 2 this was only the case for vitamin B-1. For the subjects in Group 1 compared to those in Group 2, the proportions of children with potentially inadequate intake of iron and vitamins A and C were significantly higher for both age groups ($p<0.05$). Additionally, for the 2-3 years old children significantly higher proportions of participants not meeting the EAR for zinc and vitamins B-2 and E were found in Group 1 relative to Group 2 ($p<0.05$).

Simulation scenario 1: replacing milks with matching amount of YCF

The median intakes and the intakes at the 25th and the 75th percentiles (Q1, Q3) before and after replacement of the various milks with matching amount of YCF are presented in the left side of Table 3. In this analysis run with the data from 66 subjects, we found statistically significant increases for iron and vitamins A, C and E ($p<0.05$). Calcium, zinc and vitamins B-1 and B-2 intakes were hardly affected by this substitution.

The effect of this replacement was also illustrated by reductions in the percentage of subjects with potentially inadequate nutrient intakes (<EAR), from 29% to 12% for iron, from 26% to 11% for vitamin A, from 61% to 50% for vitamin B-1, from 53% to 27% for vitamin C and from 54% to 24% for vitamin E (Figure 2a). Calcium intakes were potentially insufficient in half of the Group 1 subjects before (50%) and after (48%) simulation by replacement of the several milks with YCF. Similar results

Table 3. Intake of nutrients (median (Q1, Q3)) before and after simulation according to Scenario 1 (replacing milks with matching amounts of YCF in children consuming various milks) and to Scenario 2 (replacing YCF with matching amounts of cow's milk in children consuming only YCF)

	Scenario 1 (n=66)		Scenario 2 (n=348)	
	Before	After	Before	After
Calcium (mg)	503 (318, 768)	504 (359, 819)	540 (408, 861)	543 (397, 820)
Iron (mg)	8.8 (5.7, 15.3)	11.4 (7.8, 17.0)*	10.4 (7.6, 18.4)	6.6 (4.4, 10.6)*
Zinc (mg)	4.9 (3.8, 7.2)	5.6 (4.1, 7.7)	5.9 (4.4, 8.9)	4.6 (3.4, 6.9)*
Vitamin A (µg-RAE)	429 (207, 777)	518 (347, 832)*	581 (395, 1075)	318 (227, 459)*
Vitamin B-1 (mg)	0.5 (0.2, 0.6)	0.5 (0.3, 0.8)	0.5 (0.4, 0.8)	0.3 (0.2, 0.6)*
Vitamin B-2 (mg)	0.8 (0.6, 1.2)	0.9 (0.6, 1.2)	1.0 (0.7, 1.6)	0.9 (0.7, 1.3)
Vitamin C (mg)	33.9 (14.2, 56.6)	62.6 (34.7, 83.9)*	71.3 (46.0, 107.8)	22.0 (12.0, 39.9)*
Vitamin E (mg α-TE)	5.8 (3.1, 8.1)	6.4 (4.9, 8.0)	8.2 (5.7, 11.9)	4.1 (2.8, 6.8)*

YCF: young-child formula.
*Significantly different before and after simulation ($p<0.05$; Wilcoxon signed rank test).

were found for the proportion of potentially inadequate zinc and vitamin B-2 intakes, around 16% both before and after simulation for both nutrients Except for calcium, zinc and vitamin A proportions, all changes were statistically significant ($p<0.05$) (Figure 2a).

Simulation scenario 2: replacing YCF with matching amounts of cow's milk in exclusive YCF users

The median intakes (Q1, Q3) before and after replacement of YCF with matching amounts of cow's milk are presented in the right side of Table 3. In this scenario with 348 subjects consuming only YCF and no other milks, absolute intakes of iron, zinc, vitamins A, B-1, C and E were significantly reduced upon substitution, whereas calcium and vitamin B-2 were hardly impacted. Compared with the EAR, the percentage of children with potentially inadequate intake was increased from 11 to 45% for iron, from 8 to 19% for zinc, from 6 to 24% for vitamin A, from 49 to78% for vitamin B-1, from 15 to 69% for vitamin C and from 28 to 59% for vitamin E, after replacing YCF with matching amounts of cow's milk (Figure 2b). The increase in percentage of children not reaching EAR for vitamin B-1 (from 49 to 78%) and calcium (from 42 to 44%) were less pronounced, but still significant, while no significant impact on vitamin B-2 was found.

Figure 3 shows the result of simulation Scenario 2 in subgroups of 1-2- and 2-3 years old children (n=180 and 168, respectively). Results were similar for both age groups, with marked increases in iron, zinc, vitamins A, B-1, C and E intakes. This led to similar statistically significant increases in the proportions of children no longer meeting EAR after substitution of YCF by cow's milk (statistical significances not shown in Figure 3). For calcium there was only a statistically significant difference in 2-3 years old children. For iron, zinc and vitamin E, Figure 3 suggests that the effect of YCF substitution by cow's milk was somewhat smaller for 2-3 years old children compared to the 1-2 years old ones.

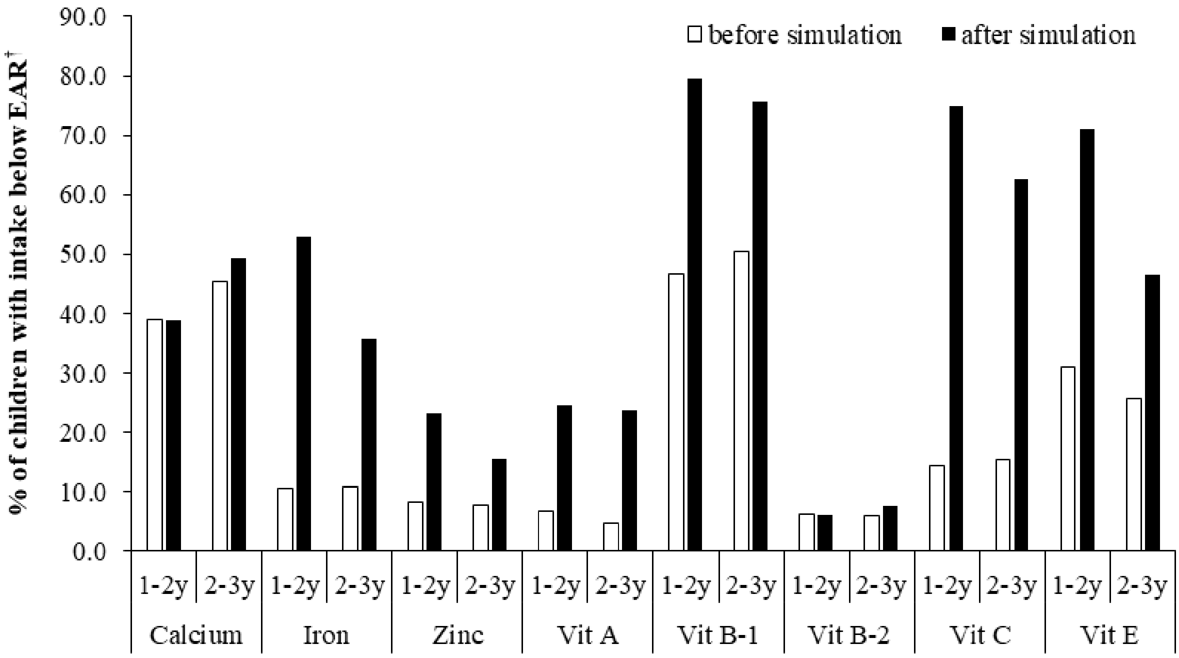

Figure 3. Percentage of 1-2- and 2-3 years old children (n= 180 and 168, respectively) with nutrient intake below EAR before and after simulation in Scenario 2 (replacing original YCF with matching amount of cow's milk in exclusive YCF users)
†EAR (Estimated Average Requirement)

DISCUSSION

There is an ongoing global scientific debate on whether the use of young-child formula (YCF) is to be recommended.[6,15] Since diets should become more and more diversified after the age of 1 year, YCF might be argued as non-essential for young children and different types of milks like cow's milk or other less expensive alternatives may be considered equivalent.

However, the present study confirms that, given the current dietary habits in urban China, young children consuming YCF are more likely to meet the EAR for micronutrients than children consuming other milks, including cow's milk. This finding is in line with the recommendation of the Chinese Nutrition Society for using YCF to support the nutrition adequacy for 1-2 years old children who are no longer breastfed.[7] Earlier studies in France and Ireland reported similar findings on the nutritional adequacy of essential fatty acids and some micronutrients intakes by YCF users compared to cow's milk users.[4,16] Moreover, descriptive and diet modelling studies based on intakes of UK young children also supported a role for YCF to cover EFSA nutrient requirements.[13,17,18] The current study confirms that the use of YCF in urban China helps to achieve adequate intake of micronutrients in young children, both before and after 2 years of age. However, it does not deal with macronutrients and other food/milk components or structures with potential physiological importance.[19]

The first communication on the underlying dietary intakes study of young urban Chin2ese children reporting anemia prevalence of 17.2 and 8% in 6-12- and 12-24 month-old children, respectively, showed that anemic children had a lower iron intake than non-anemic children, and that formula milk was a major contributor to iron intake.[10] This confirmed earlier studies which suggested that consuming a formula milk specifically designed for young children might help to support adequate iron intakes.[4,16] Exchanging non-iron fortified milks with YCF in Scenario 1 significantly improved iron intake and reduced the percentage of children having inadequate iron intakes (<EAR) by more than half, compared to the actual situation. This is consistent with the simulation study based on the 2011 UK Diet and Nutrition Survey of Infants and Young Children (n=1275) where the great majority of young children consumed only cow's milk.[13] In that country, an earlier study already reported an association between low iron status and high cow's milk and cream consumption (>400 mL/d). The authors interpreted this observation as an undesired substitution of iron rich foods like meat, fish, fruit and nuts with cow's milk.[19] Similar findings were reported in a study in 2-years old Icelandic children.[20] A recent randomized, controlled, double blinded study in 1-3 years old children in Germany, the Netherlands and the UK, comparing YCF and cow's milk during a 20 weeks intervention study, revealed that in subjects who received non-fortified cow's milk, iron deficiency increased from 12 to 30%, while it remained stable at 14% in subjects which received YCF.[8] The very recent study from New Zealand and Australia used a different definition for iron deficiency, but essentially obtained the same results: an increase of iron deficiency from 21 to 24% in the cow's milk group and a decrease from 11 to 7% in the YCF group.[9]

In our simulation results, the impact of milk or YCF substitution on suboptimal calcium intakes (<EAR) in milk users was limited. This can be attributed to a comparable amount of calcium present in cow's milk and current YCF on the Chinese market (about 104 mg/100 mL in cow's milk vs 112 mg/100 mL in the studied YCF, typical levels in most YCF currently on the market). Interestingly, in the International Expert Recommendation on the composition of YCF, the minimum calcium level was set at 200 mg/100 kcal, equivalent to 140 mg/100 mL at an energy density of 70 kcal/100 mL; this high level was chosen to accommodate for a target intake volume of 300 mLday.[15] In this respect it is relevant to note that the latest recommendation on dairy product consumption from the Chinese Nutrition Society (CNS) for 2-5 years old children is fixed at 300-400 mL/day while for 1-2 years old children who are not breastfed, 500 mL YCF is recommended.[7] The observation that the proportion of Group 2 children with suboptimal calcium intake (not meeting the EAR) of 43%, compares favorably to this proportion in Group 1 children (50%) is mainly attributed to the difference in average consumption of any milk (535 vs. 379 mL/day, respectively), with less children in Group 2 having milk consumption below the CNS intake volume recommendations.[7] As we have taken total dietary intake into account, our study data nicely illustrate that the YCF or cow's milk volume intake recommendations by the CNS are well matched with the EAR.[14]

Our findings on limitations in the micronutrient intakes in young children of vitamins A, C, E, iron and zinc are fully or partially in line with other studies or reviews.[4-6,13,16,17] However, vitamin B-1 was not identified as a problem nutrient for young children in these mainly Europe-focused studies. Moreover, the International Expert Group decided not to deem low intake of vitamin B-1 as a global concern based on studies from Brazil and the Philippines only.[15] Based on the marginal vitamin B-1 intakes in young children from our survey in urban China and the recent results of the GUM-Li study obtained from New Zealand,[21] we suggest to add vitamin B-1 to the list of nutrients deserving special attention in the diet of young children. It has been suggested that correction of vitamin insufficiencies in children's diet can be effectively achieved by non-milk foods including vegetables, fruits and cereals, except for vitamins D and B-12.[4] For these vitamins, also the volume of milk consumed needs to be considered, which is illustrated by the fact that substitution of milks by YCF in Scenario 1 did not lead to such marked difference as was seen in Scenario 2, where somewhat larger intake volumes were substituted.

The segmentation of our study population based on the use of any milk or exclusively YCF was rather arbitrary and done only for performing meaningful simulation analyses. However, in addition to the type of milk consumption we also found remarkable differences in baseline food group consumptions in these groups. Children in Group 2 (exclusive YCF consumption) had a higher vegetable consumption in both age ranges and a higher fruit consumption amongst 2-3 years old children. Although these differences were not statistically significant using non-parametric tests, it is plausible that they contributed to the lower proportions of children in Group 2 not meeting EAR for 6 out of the 8 studied nutrients. Nevertheless, in comparison with the China dietary recommendations, also the Group 2 children comprising 84% of the selected children for this simulation study or 70% of the recruited 1-3 years old children in the original dietary survey, fell short of the recommended intakes of vegetables, fruits and meat (Table 2a). The baseline food groups consumption in Group 2 was in good agreement with the results from another recent study in urban China using a similar methodology, and their recommendation to encourage the consumption of fruits and vegetables and increase consumption of foods sources of iron like lean red meat.[22] These insights in the background diet of young children in urban China should also be seen as an opportunity for nutrition education and dietary intervention and illustrate that YCF represents only one of the potential options to compensate for nutritional deficiencies which may occur in the transition phase of infant nutrition to family foods, particularly when bad dietary patterns prevail in the family.[23]

A shortcoming of this study is that we limited our analyses to micronutrients only. We decided not to analyze energy, protein (% of energy), fat and sugar due to some ambiguities in the original daily intake records, as cooking oil and sugar intake were not recorded.[11] Moreover, in the original dietary survey details on fat quality, dietary fiber and Vitamin D intake were not processed because the information on these nutrients/components in the used food tables was incomplete. Because of the cross-sectional design of the original dietary survey,[11] children with (self-reported) food allergies or intolerances were excluded. For this study, we additionally excluded 7 exclusive goat milk or soya milk users as they might still follow a special diet due to (perceived) allergies. Therefore, the substitutions performed in our study always dealt with removing cow's milk or milk derived products and exchange them for either intact cow's milk protein based YCF or cow's milk and can thus be considered neutral as to potential risk for cow's milk protein sensitization and/or allergy. A typical limitation of theoretical simulation studies like ours is the impact of the selection of commercial product compositions for removal and substitution to the diet. We aimed to minimize this by selecting nutritional composition of cow's milk and traditional soya milk from the Chinese food composition tables and applying the compositions of commonly used variants of Kid's Milk and YCF.

Because the "double-burden" situation in urban China (wasting/stunting together with an increased prevalence of toddler obesity/overweight) has clearly evolved into a Western like situation where obesity/overweight has become the major concern, future studies need to adequately collect these dietary data and focus on the relevance of YCF to also support adequate macronutrients intake. In simulation analyses where the great majority of young children in Europe consumed cow's milk, substitution with YCF resulted in clear nutritional improvements both with respect to macro- and to micronutrients.[13] Our study in urban China confirmed that a major part of young children already consumed adequate amounts of YCF. Nevertheless, in the smaller group of children consuming various types of milk with or without a limited amount of YCF, we found a similar pattern as in the European study. Interestingly, using the opposite strategy and substituting YCF with cow's milk in the larger Group 2, we found the same nutrients impacted, but in a negative way. Thus, both scenarios support our conclusion that YCF is relevant in the current diet of young children in urban China.

In view of the rapid changes in dietary consumption patterns in urban China in the past decade, we recommend repeating similar simulation analyses in the next few years with updated dietary intake data. The recent ESPGHAN Committee on Nutrition position paper pointed out that the clinical relevance of improved iron status upon using YCF is not clear and asked for additional studies on the health effects of YCF on the children.6 In addition, Matsuyama et al. addressed in their systematic review the lack of economic evaluations done for fortified milks for young children on anemia reduction.[24] Such studies could provide new arguments to the cost considerations discussion on YCF versus cow's milk. Reports from Brazil and India demonstrated that iron fortification programs of milk and/or cereals were clearly cost-effective.[25,26]

In conclusion, this study supports the role of YCF consumption to meet the recommended intakes in several micronutrients (calcium, iron, zinc, vitamin A, B-1, C and E), given the current dietary practices of urban Chinese young children. In line with Chinese recommendations, YCF may be considered the preferred milk choice for non-breastfed children of 1-2 years, and its use can also be supported for 2-3 years old children.

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AUTHOR DISCLOSURES

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