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Less Traditional Diets in Chinese Mothers and Children Are Similarly Linked to Socioeconomic and Cohort Factors but Vary with Increasing Child Age[1–3]

Tracy Dearth-Wesley,[4] Penny Gordon-Larsen,[4] Linda S. Adair,[4] Anna Maria Siega-Riz,[4] Bing Zhang,[5] and Barry M. Popkin[4]*

[4]Department of Nutrition and Carolina Population Center, University of North Carolina, Chapel Hill, NC; and [5]National Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, Beijing, China

Abstract

Global shifts toward an increasingly Western diet and rises in nutrition-related noncommunicable diseases necessitate systematic examination of dietary change in adults and children. This study longitudinally examined mother and child dietary intakes and their relationship with socioeconomic factors across 4 mutually exclusive cohorts followed over 6- to 7-y time periods (cohort A: 1991–1997, cohort B: 1993–2000, cohort C: 1997–2004, cohort D: 2000–2006). The cohorts included 966 mother-child pairs (children 3–5 y at baseline) from the China Health and Nutrition Survey. Dietary intake was assessed using 24-h recall and household food consumption data; dietary variables were the percentage of total energy from animal-source foods (ASF), fats/oils, and grains. Mother-child comparison of dietary variables used average annual change measures, Spearman partial correlations, random effects models, and seemingly unrelated regression models and estimation. Whereas children were earlier adopters and maintainers of a less traditional Chinese diet, mothers experienced greater shifts away from the traditional Chinese diet with increasing child age. Mother-child correlations for the dietary variables ranged from 0.46 to 0.89 ($P < 0.001$). Similar increased intake of ASF and decreased intake of grains were reported for mothers and children of urban (vs. rural) residence and with higher levels of maternal education ($P < 0.001$). A comparable cohort effect was shown, with mothers and children consuming a less traditional Chinese diet in the later (C and D) compared to earlier (A and B) cohorts ($P < 0.05$). Our findings provide insight into dietary changes in mothers and children within the context of a rapidly changing nutrition and socioeconomic environment. J. Nutr. 141: 1705–1711, 2011.

Introduction

Global research on dietary change reveals universal shifts toward a diet higher in edible oils and ASF[6] and lower in fiber (1). Underlying factors driving this dietary shift include expansion of the global mass media and advancements in food processing, production, marketing, and distribution (1–3). Dietary changes in newly industrialized and developing countries are also enhanced by rapid socioeconomic change and urbanization, thus leading to alarming increases in nutrition-related noncommunicable diseases (4,5). Limited intervention and policy success preventing further shifts toward an increasingly Western diet and consequent rises in nutrition-related noncommunicable diseases requires improved understanding of global nutrition dynamics within the context of a rapidly changing nutrition and socioeconomic environment.

More effective and well-targeted nutrition policy and intervention efforts require systematic examination of dietary changes in adults compared to children. Past research on adult-child dietary intake is mostly cross-sectional and focused on macronutrient composition or intake of specific nutrients (6–15). A recent meta-regression analysis of these studies found moderate to weak parent-child dietary associations with notable variations with respect to study type, dietary assessment method, and dietary indicators (16). Longitudinal studies have largely concentrated on the parent-child relationship for fruit and vegetable consumption; parental dietary patterns and the family food environment are

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[3] Supplemental Material is available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at jn.nutrition.org.
[6] Abbreviations used: ASF, animal-source food; CHNS, China Health and Nutrition Survey; FCT, Food Composition Table; SES, socioeconomic status; % E, percentage of total energy.
* To whom correspondence should be addressed. E-mail: popkin@unc.edu.

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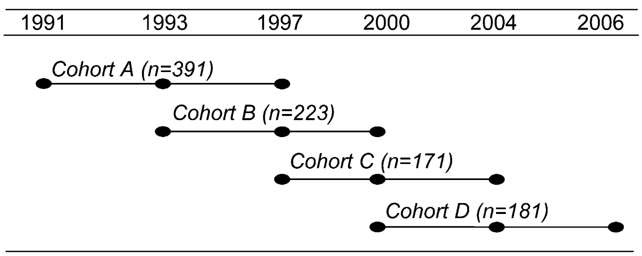

FIGURE 1 Mother-child cohorts and corresponding survey years [China Health and Nutrition Survey (CHNS)].

more often examined as they relate to weight changes rather than dietary patterns in children (17–23). Longitudinal research focused on the similarities and differences between parent and child dietary intake is needed to elucidate how shifts toward an increasingly Western diet vary in adults compared to children.

To understand how parent and child dietary intake relates to socioeconomic factors and responds to changes in the nutrition environment, we investigated dietary intake in 4 mutually exclusive cohorts of Chinese mother-child pairs. Each cohort was followed over a separate 6- to 7-y time period using data from the CHNS: cohort A: 1991–1997, cohort B: 1993–2000, cohort C: 1997–2004, and cohort D: 2000–2006. The primary study objectives were to compare dietary intake in mothers and children over time and across different time periods and to examine the relationship between dietary intake and socioeconomic or cohort variables. The study design facilitated investigation into the effect of child age on mother and child dietary intake and comparison of mother-child dietary intake across cohorts with varying penetration of Western media, modern food processing, and supermarket growth. The cohorts also spanned the last couple decades in China, which enabled examination of how mother and child dietary intake changes during rapid socioeconomic development.

Materials and Methods

Data and participants. Longitudinal data from the CHNS were used. The CHNS began in 1989 with subsequent surveys every 2–4 y. A multistage, randomized cluster design was utilized to survey ~4400 households and roughly 19,000 individuals from 9 Chinese provinces that varied in geography, socioeconomic growth, and health indicators. The study met the standards for the ethical treatment of participants and was approved by the University of North Carolina at Chapel Hill and the Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention. Additional CHNS details are available in previous publications (24–26).

Our study sample included 4 mutually exclusive cohorts of biological mother-child pairs followed over 6- to 7-y time periods. Each cohort had survey measurements from 3 points in time (**Fig. 1**). Children in each cohort were 3–5 y of age at baseline and followed until 9–12 y of age. Inclusion criteria included dietary data for mothers and children from 3 time points, resulting in a study sample of 966 mother-child pairs and a follow-up rate of 44%. A likely contributor to the lower follow-up rate was the stringent inclusion criteria requiring 6 complete sets of dietary data gathered over time for each mother-child pair. However, mothers and children lost to follow-up did not significantly differ from the study sample with respect to baseline residence, income, maternal education, child's age, and all dietary intake variables. Differences were found for maternal age and child's gender ($P < 0.05$) and these were adjusted for, because gender differences in dietary fat intake among Chinese children have been shown (27). We did not adjust for sampling design, because past CHNS research found that adjustments were necessary only when community level factors were examined (28).

Measures. CHNS data were collected using structured questionnaires administered by trained field staff to all household members. Parents or

TABLE 1 Baseline characteristics of mother-child pairs by cohort [China Health and Nutrition Survey (CHNS)][1,2]

	Cohort A	Cohort B	Cohort C	Cohort D
Survey years	1991, 1993, 1997	1993, 1997, 2000	1997, 2000, 2004	2000, 2004, 2006
n	391	223	171	181
Child's gender, *% male*	61.6	58.3	59.7	51.4
Child's age,* *y*	4.3 ± 0.9	3.9 ± 0.6	4.4 ± 0.9	4.3 ± 0.9
Child's energy intake,† *kJ/d*				
3–5 y	5.99 ± 2.03	5.53 ± 2.09	5.15 ± 2.03	5.21 ± 2.23
6–9 y	6.83 ± 2.24	6.76 ± 2.05	6.89 ± 2.73	6.73 ± 2.40
10–12 y	7.75 ± 2.14	7.85 ± 2.30	8.14 ± 2.67	6.88 ± 2.15
Mother's age,* *y*	31.7 ± 5.1	31.7 ± 4.8	30.3 ± 3.6	30.6 ± 3.7
Mother's BMI, *kg/m²*	21.6 ± 2.8	21.5 ± 2.4	22.0 ± 3.1	21.8 ± 2.6
Mother's energy intake,† *kJ/d*				
Children 3–5 y	11.0 ± 2.80	10.8 ± 3.40	9.32 ± 2.56	9.31 ± 3.14
Children 6–9 y	10.8 ± 3.35	9.50 ± 2.67	9.44 ± 2.71	9.19 ± 2.56
Children 10–12 y	9.44 ± 2.38	9.38 ± 2.67	9.25 ± 2.70	8.72 ± 2.49
Mother's education,* *%*				
None/primary school	45.8	49.8	50.0	45.4
Middle school	35.4	35.0	33.3	36.8
High school	16.7	13.0	11.3	8.6
College, technical or higher	2.1	2.2	5.4	9.2
Annual household income,* *yuan*[3]	9556 ± 8232	10502 ± 8840	13491 + 11099	16792 + 17034
Household residence, *% rural*	74.7	78.5	74.9	77.4

[1] Values are mean ± SD or percentage. *Different across cohorts, $P < 0.001$. †Different across cohorts, $P < 0.05$.
[2] Data were missing for mother's age ($n = 9$), mother's BMI ($n = 96$), mother's education ($n = 12$), and household income ($n = 31$).
[3] Annual household income inflated to 2006 yuan currency values.

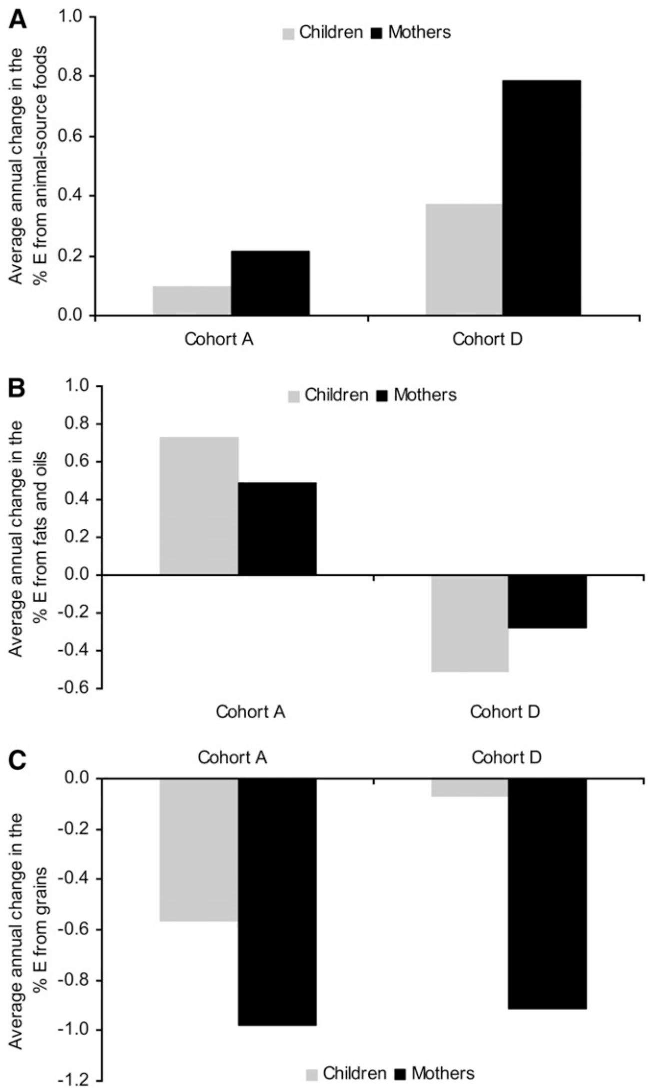

FIGURE 3 Average annual changes in the percentage of energy (%E) from animal-source foods, fats/oils, and grains for mothers and children in the earliest (A) and latest (D) cohorts [China Health and Nutrition Survey (CHNS)].

primary caregivers completed dietary information for children <12 y and the same dietary assessment tools were used for mothers and children. Age and gender were self-reported; details on SES measures have been previously published (29). Dietary data included household food consumption data and 3 consecutive 24-h recalls, with data collection randomly allocated during the week. The 1991 Chinese FCT was used to determine nutrient values for dietary data from 2000 and before. The 2002 FCT was used for the 2004 survey and the 2004 FCT was used for the 2006 survey. Mean daily dietary values were determined using the 3 d of dietary information. The CHNS dietary assessment approach has been shown to reduce the effects of measurement error and accurately capture usual energy intake (30,31).

Dietary variables were the % E from ASF, fats/oils, and grains. The % E from ASF and grains was determined using the 24-h recall data and food groups specified by the China Food Grouping System (**Supplemental Material**).

ASF included beef, pork, poultry, meat products, eggs, and egg products and excluded animal fats, such as beef tallow or lard. Grains included rice, wheat flour and wheat products, and corn flour and corn products. Rice- or wheat-based cakes, cookies, and pastries were excluded, because these foods represent more processed grains less characteristic of the traditional Chinese diet. The % E from fats/oils consisting of plant oils, beef tallow, lard, and butter was determined using household food consumption data. To determine individual oil consumption, the proportion of the individual's intake of household foods cooked with fats/oils relative to the total household intake of foods cooked with fats/oils was multiplied by the total amount of fats/oils used by the household. The individual consumption of fats/oils in kilocalories was divided by the total daily energy intake to determine the % E from fats/oils. Dietary values were excluded if they fell beyond the far upper or lower fences of the box and whisker plots as determined separately for mothers and children by cohort and survey year.

Statistical analysis. Significant differences across the cohorts with respect to baseline characteristics were examined using 1-way ANOVA and chi-squared tests. Mother-child differences for dietary variables were tested using the Wilcoxon's-Mann Whitney test. Mother-child comparison of changes in the % E from ASF, fats/oils, and grains was examined using an average annual change measure. Because each cohort had 3 survey time points, the reported average annual change measure was the mean of the average annual change measures from baseline to midpoint and from midpoint to follow-up. Each annual change measure was calculated by dividing the dietary value difference from the 2 survey time points by the number of years between the 2 survey time points. Spearman

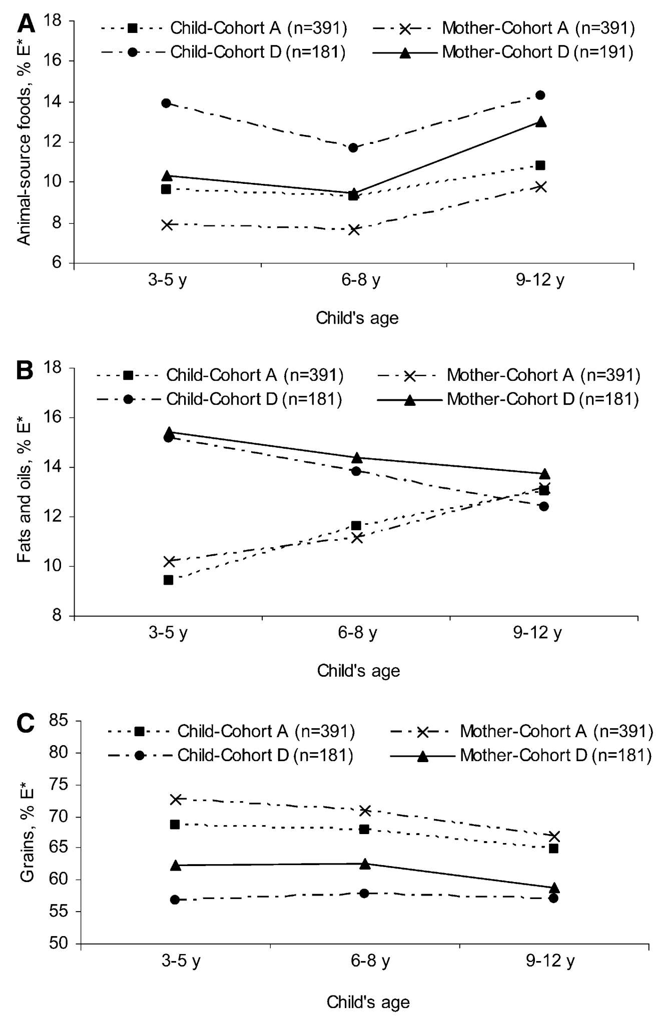

FIGURE 2 Percentage of energy (%E) from animal-source foods (ASF), fats/oils, and grains for mothers and children over time in the earliest (A) and latest (D) cohorts [China Health and Nutrition Survey (CHNS)]. *Mother-child differences for all child's age periods by cohort were found for the % E from ASF and grains variables ($P < 0.05$). For the % E from fats and oils, mother-child differences were found for cohort A (child's age 6–8 y) and cohort D (child's age 9–12 y) ($P < 0.05$).

TABLE 2 Mother-child correlations for the percentage of energy (% E) from animal-source foods (ASF), fats/oils, and grains by cohort [China Health and Nutrition Survey (CHNS)][1,2]

	% E from ASF			% E from fats and oils			% E from grains		
	Child age 3–5 y	Child age 6–8 y	Child age 9–12 y	Child age 3–5 y	Child age 6–8 y	Child age 9–12 y	Child age 3–5 y	Child age 6–8 y	Child age 9–12 y
Cohort A	0.87	0.88	0.93	0.66	0.77	0.84	0.74	0.83	0.85
Cohort B	0.86Ï	0.89	0.89Ï	0.69Ï	0.76	0.80	0.73Ï	0.83	0.83
Cohort C	0.83Ï	0.86	0.89Ï	0.68Ï	0.75	0.80	0.82Ï	0.67	0.77
Cohort D	0.74*	0.87	0.80*	0.62*	0.75	0.82	0.46*	0.78	0.81
All Cohorts	0.84	0.87	0.89	0.68	0.77	0.82	0.73	0.80	0.83

[1] Correlations adjusted for child's gender and age, mother's education and age, annual household income, and residence.
[2] All correlations different from 0, $P < 0.001$. *Different from cohort A, $P < 0.05$.

partial correlations were also calculated to examine the mother-child dietary relationship at each time point and by cohort. Significant differences between correlations were based on Fisher's z transformation of the correlations.

For mother-child comparison of the effects of SES variables, cohort, and interactions between SES variables and cohort on the dietary outcomes, a 2-step approach was utilized. First, we used maximum likelihood random effects models with backward deletion to separately determine the most parsimonious equations for examining the longitudinal relationship between the dietary outcomes and SES and cohort variables in mothers and children. Interaction terms with the largest SE relative to their *P*-value were removed first, and likelihood ratio tests were done comparing the reduced model to the full model. These models separately accounted for the correlation in repeated measurements for individuals (range 0.16–0.35). For the % E from grains and fats/oils, the final equations were then used in seemingly unrelated regression models, which enabled testing of the equality of the coefficients for the mother and child equations with consideration of correlated error terms. For the % E from ASF, the final equations were then used in a tobit model followed by seemingly unrelated estimation. The direct and indirect effects of the SES or cohort variables were determined using the nonlinear combinations of estimators command in Stata providing regression coefficients (95% CI).

Results

Significant differences across the cohorts were found for child's age, mother's age and education, mothers' and children's total dietary intake, and annual household income ($P < 0.05$) (**Table 1**). No significant differences across the cohorts were found for child's gender, maternal BMI, or household residence.

Cohorts A and D were used when examining dietary trends and average annual changes in order to simplify cross-cohort comparisons. Mothers and children in the latest (D) compared to earliest (A) cohort consumed a less traditional diet at all time points, particularly for the % E from ASF and grains measures (**Fig. 2**). Significant differences were found between mothers and children in both cohorts for the % E from ASF and grains across all child's age periods ($P < 0.05$). The % E from fats/oils was not significantly different across most mother-child comparisons.

In the earliest and latest cohorts, mothers experienced average annual changes in the % E from ASF over 2 times greater than those of children (**Fig. 3**). Average annual changes in the % E from fats/oils were similar for mothers and children by cohort. For the % E from grains, mothers (vs. children) in both cohorts experienced greater annual reductions in grains. Comparison by cohort showed greater annual increases in the % E from ASF for mothers and children in the latest cohort, contrasting changes in the % E from fats/oils, and greater reductions in the % E from grains for mothers and children in the earliest cohort.

Mother-child correlations for the dietary variables ranged from 0.46 to 0.89 ($P < 0.001$) (**Table 2**). Increases in mother-child correlations were found with increasing child age group across all cohorts for the % E from ASF, fats/oils, and grains variables. Significant differences in the mother-child correlations for all food groups were found between the earliest and latest cohorts at child age 3–5 y, indicating less similar mother-child diets in the latest survey years ($P < 0.05$).

The relationships between the % E from food groups and SES or cohort variables for mothers and children were examined (**Table 3**). Testing of the equality of mother-child coefficients indicated that urban (vs. rural) and higher levels of maternal education were associated with greater % E from fats/oils in mothers compared to children ($P < 0.01$). In contrast, SES and cohort variables did not differentially affect the % E from ASF or grains in mothers compared to children. Similar increases in the % E from ASF and decreases in the % E from grains for mothers and children were found with urban (vs. rural) residence, higher levels of maternal education, and later cohorts. Significant differences in the % E from ASF and grains were found for mothers and children with respect to the age group of child. Compared to when the children were 3–5 y old, mothers (vs. children) consumed a higher % E from ASF (1.65 and 0.15%, respectively) and lower % E from grains (−4.01 and −1.55%, respectively) when the children were 9–12 y old. There was no relationship between income and the dietary variables for mothers or children.

Discussion

Our study provided a more comprehensive understanding of mother and child nutrition dynamics, with particular emphasis on how child age, SES, and cohort factors relate to dietary intake for mothers and children. We found that whereas children were earlier adopters and maintainers of a less traditional diet, mothers experienced greater shifts away from the traditional Chinese diet with increasing child age. Despite these differences, we also found considerable similarities between mother-child dietary intake patterns and their relationship with SES variables. Furthermore, a comparable cohort effect was shown for mothers and children, which indicated markedly less traditional diets for mothers and children in the later (C and D) compared to earlier (A and B) cohorts.

Significant mother-child differences in the % E from ASF and grains were found across all child age periods, with children compared to mothers adopting and maintaining a less traditional Chinese diet over time. It is hypothesized that these differences are influenced in part by dietary implications of the

TABLE 3 Associations between socioeconomic or cohort variables and the percentage of energy from animal-source foods (ASF), fats/oils, and grains [China Health and Nutrition Survey (CHNS)][1]

	ASF		Fats/oils		Grains	
	Child	Mother	Child	Mother	Child	Mother
Household residence						
Rural	Ref	Ref	Ref	Ref	Ref	Ref
Urban	3.22 (2.93, 3.52)*	3.42 (3.14, 3.70)*	1.46 (1.27, 1.65)*#	2.82 (2.63, 3.00)* #	−5.92 (−6.08, −5.75)*	−6.11 (−6.30, −5.92)*
Annual household income[2]	−0.14 (−0.88, 0.61)	0.08 (−0.63, 0.78)	−0.32 (−0.83, 0.19)	−0.46 (−0.95, 0.03)	0.36 (−0.52, 1.23)	0.17 (−0.65, 0.99)
Maternal education						
None/primary	Ref	Ref	Ref	Ref	Ref	Ref
Middle school	3.91 (2.90, 4.93)*	3.12 (2.75, 3.48)*	0.23 (−0.43, 0.91)#	1.18 (0.53, 1.83)*#	−4.53 (−4.69, −4.36)*	−4.64 (−4.80, −4.49)*
High school	5.12 (3.84, 6.41)*	5.25 (4.04, 6.46)*	0.86 (−0.09, 1.81)#	1.74 (0.82, 2.66)*#	−6.31 (−7.96, −4.66)*	−6.68 (−6.76, −6.59)*
Technical, college or higher	8.07 (8.00, 8.15)*	6.39 (4.43, 8.36)*	0.17 (−1.46, 1.80)#	2.69 (2.65, 2.74)*#	−11.8 (−11.9, −11.8)*	−13.2 (−15.8, −10.5)*
Cohort						
Cohort A	Ref	Ref	Ref	Ref	Ref	Ref
Cohort B	−0.56 (−0.90, −0.22)‡	0.05 (−0.32, 0.42)	0.80 (0.48, 1.11)*	1.70 (1.39, 2.00)*	−1.87 (−2.31, −1.44)*	−2.23 (−2.65, −1.95)*
Cohort C	1.52 (1.20, 1.84)*	0.54 (0.21, 0.87)‡	2.97 (2.68, 3.25)*#	4.56 (4.28, 4.84)*#	−8.79 (−9.18, −8.40)*	−7.99 (−8.30, −7.68)*
Cohort D	1.24 (0.83, 1.66)*	0.65 (0.22, 1.08)†	6.43 (6.11, 6.75)*	6.20 (5.89, 6.51)*	−9.83 (−10.3, −9.37)*	−9.83 (−10.2, −9.45)*
Age of child						
Child 3–5 y	Ref	Ref	Ref	Ref	Ref	Ref
Child 6–8 y	−1.06 (−2.15, 0.03)#	−0.40 (−1.36, 0.56)#	1.15 (0.86, 1.45)*	0.75 (0.46, 1.03)*	0.42 (0.09, 0 0.75)‡	−0.67 (-1.86, 0.52)
Child 9–12 y	0.15 (−0.95, 1.25)#	1.65 (0.68, 2.63)†#	2.29 (1.98, 2.56)*	2.07 (1.78, 2.37)*	−1.55 (−1.89, −1.21)*#	−4.01 (−5.21, −2.81)*#

[1] Values are regression coefficient (95% CI). $*P < 0.0001$, $^{\dagger}P < 0.01$, $^{\ddagger}P < 0.05$. #Rejection of null hypothesis that mother and child coefficients are equal ($P < 0.01$).
[2] A one-unit increase in income is equal to 1000 yuan.

"compensation syndrome." Given their past experiences during the Cultural Revolution, Chinese parents want to give their children everything they did not have as a child and are now able to provide their children with diverse and plentiful foods (32,33). Dietary implications of this are hypothesized to include dietary sacrifices made by parents toward their children, which may in part explain why we found children preceding mothers in having a diet higher in ASF and lower in grains. Later shifts toward a less traditional diet in mothers are hypothesized to be a consequence of the increased affordability, accessibility, and availability of more Western foods (1,2).

Examination of mother-child correlations for the dietary variables showed moderate to strong correlations (range 0.46–0.89). These findings are stronger than those of past studies, which may in part be a consequence of dietary assessment or methodological differences among the studies or indicative of more similar dietary patterns in Chinese mothers and children (6,8,10,12–16). The mother-child dietary intake associations found in our study highlight the need for nutrition policy and intervention efforts targeted at the family level.

A comparable relationship was found between SES factors and the diets of mothers and children. Urban (vs. rural) residence was associated with a less traditional diet for mothers and children, a finding that is well supported by previous dietary research in China (26,34,35). We also found that increasing levels of maternal education were associated with increasingly unhealthy diets of mothers and children. This relationship has been documented in other studies and demonstrates the Chinese lifestyle transition associated with SES (26,35,36). Chinese of higher SES have more exposure to and a greater ability to adopt a more Westernized lifestyle; the level of education in China is not high enough to prevent the shift toward a less healthy lifestyle (36). Although this shift has historically been more characteristic of Chinese of higher SES, rapid socioeconomic change has also accelerated similar lifestyle changes among those of lower SES (37,38).

Our study further documented dietary intake similarities between mothers and children with respect to cohort. Compared to cohorts A and B, mothers and children in cohorts C and D had a markedly less traditional Chinese diet. Although these findings are similar to past dietary trend research in China (38,39), the distinct dietary differences in the later compared to earlier cohorts are of particular interest. Probable contributors to this cohort difference are the rapid growth of multinational and domestic supermarkets, rapid increase in television ownership, and increasing presence of the Western media in the mid- to late 1990s (2,38,40,41).

There are some study limitations that necessitate explanation. Our stringent inclusion criteria raise the concern of selection bias associated with loss to follow-up. However, previous longitudinal research on dietary intake patterns in Chinese youth using CHNS data found nonsignificant changes in estimates after correcting for selection bias (26). A second limitation is the possibility of inaccurate dietary assessment in mothers and children, but research on the CHNS dietary assessment approach found no underreporting by men and only a small degree of underreporting (8%) by women (30). A 3rd limitation is the potential for same-source bias. A mother self-reporting her own dietary intake and that of her child could lead to falsely high mother-child correlations for dietary intake. A final study limitation was the lack of consideration for dietary intake patterns of grandparents. Grandparents play an influential role in children's eating behaviors (42,43); thus, inclusion of the dietary patterns of grandparents would have contributed to a deeper understanding of how children's dietary patterns are shaped by the family dietary environment.

Our study was unique in examining the longitudinal mother-child dietary intake across separate periods of time. Our selection of dietary intake variables expanded upon existing dietary research in China and was dually advantageous: relative measures of dietary intake allow adjustment for age and gender, tracking of dietary patterns, and often adjust for reporting errors

(26); selection of the specific food groups allowed us to examine dietary shifts characterizing a less traditional Chinese diet. The extensive nature of the CHNS dietary data and use of the same dietary assessment tools in mothers and children enabled more accurate and systematic examination of dietary intake patterns in mothers and children, resulting in new insight into how mother and child dietary intake evolves over periods of rapid socioeconomic growth in China.

Although similarities in mother-child dietary patterns support the need for nutrition interventions focused at the family level, mother-child dietary differences suggest that these interventions must also be mindful of cultural norms and parental attitudes toward child nutrition. The success of these interventions will continue to be challenged by a nutrition environment where more Western foods are increasingly available, accessible, and affordable. We postulate that there would be considerable overlap in our findings with mother-child dietary research in other countries experiencing rapid economic development and nutritional environment changes, but more research is needed. Future research must also integrate findings on mother and child dietary intake with other underlying determinants of energy balance, such as physical activity patterns, to better understand their relationship to overweight and obesity in adults and children.

Acknowledgments

T.D-W. and B.M.M. designed research; T.D-W. conducted research and analyzed data; T.D-W. and B.M.M. wrote the paper and had primary responsibility for the final content; and P. G-L., L.S.A., A.M.S-R., and B.Z. provided important advice or consultation. All authors read and approved the final manuscript.

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