Cheng, G., Kranz, S., Libuda, L., & Zhang, L. (2016). Development of a Dietary Index to Assess Overall Diet Quality for Chinese school-aged Children: The Chinese Children Dietary Index (CCDI). Journal of the Academy of Nutrition and Dietetics, 116(4), 608-617. DOI: 10.1016/j.jand.2015.11.010

Development of a Dietary Index to Assess Overall Diet Quality for Chinese school-aged Children: The Chinese Children Dietary Index (CCDI)

ABSTRACT

Background: A composite measure of diet quality is preferable to an index of nutrients, food groups or health-promoting behaviors in dietary assessment. However, to date such a tool for Chinese children is lacking.

Objective: Based on the current Chinese Dietary Guidelines and Dietary Reference Intakes, a dietary index for Chinese school-aged children, the Chinese Children Dietary Index (CCDI) was developed to assess overall diet quality among children in South China.

Design/Subjects: Dietary data were recorded using 24-hour recalls among 1719 children aged 7-15 years between March and June 2013. Inactivity data and socio-demographic information were also collected. The CCDI included 16 components, which incorporated nutrients, foods/food-groups and health-promoting behaviors. The range of possible CCDI scores was 0-160, with a higher score indicating better diet quality.

Statistical analysis performed: Pearson/spearman correlation was used to assess relative validity using correlations between total CCDI score and age, body mass index (BMI), inactivity, whole grain intake, frequency of fried foods intake, nutrient adequacy ratios for energy intake and 12 nutrients not included in the CCDI, and the

mean adequacy ratio (MAR). Finally, a stepwise multiple regression analysis was performed to indicate the factors correlated with CCDI.

Results: The mean CCDI score of this sample was 88.1 points (range: 34.2-137.8), the CCDI score of girls was higher than that of boys and decreased with higher age. Children with higher CCDI had lower BMI and spent less time being inactive. Positive associations were observed between CCDI and the majority of nutrient adequacy ratios and the MAR. Age, paternal educational level and family size were correlated with CCDI.

Conclusion: The CCDI successfully differentiated diets, hence, it can be used to rank-order overall diet quality among Chinese children. As the results showed, diet quality among Chinese children needs to be improved, especially in adolescents.

Keywords: Diet quality; Dietary Index; Child; Adolescent; China.

INTRODUCTION

The impact of energy intake, nutrients or foods and food groups on health has been investigated systematically over the last years [1, 2]. However, analyses which focus on a single or a few nutrients or foods have several conceptual limitations. People consume foods, not individual nutrients, and advice on selected dietary components is not

conducive to understanding dietary intake habits. Overall diet quality, which takes the interactions of nutrients and foods into account may be easier for the public to interpret or to translate into daily diets [3]. It is impossible to measure overall diet quality directly. To date, dietary indices, which are based on current dietary recommendations released by authorities, are used to measure whether diets adhere to those guidelines and to characterize the dietary patterns.

Nearly 30 dietary indices including nutrients, foods/food groups or a combination of both have been developed or modified for children from the United States (toddlers, 2-18 years) [4-13], Australia (infants, toddlers, 4-16 years) [14-18], Germany (0-17 years) [19-23], Finland (1-6 years) [24], Spain (2-24 years) [25-27] and Canada (older than 3 years) [28, 29]. A few dietary indices measured diet quality among children in Asian countries [30-34]. These indices were food based and reflect dietary diversity among Philippine non-breastfed infants [30], Cambodian infants and toddlers [31], Bangladeshi children (0.5-5 years) [32], Indian vegetarian girls aged 10-16 years [33] and Iranian adolescents [34]. They are based on the assumption that diets with a variety of foods/food groups are more likely to be nutritionally adequate. However, the scores were not adjusted for total energy intake, which is correlated with dietary diversity [2]. Because of the different dietary pattern and lifestyle between Chinese children and children from western countries or west/south Asia, the existing dietary indices are inappropriate to measure the diet quality of Chinese children. To date, an index assessing diet quality in Chinese children and adolescents has not been developed.

The aims of this study were to develop a dietary index specific to the needs of

Chinese school-aged children (the Chinese Children Dietary Index (CCDI)) and to assess overall diet quality among Chinese children and adolescents in South China based on current Chinese dietary intake recommendations (Chinese Dietary Guidelines [35] and Chinese Dietary Reference Intakes (DRIs) [36]) and suggested health-promoting behaviors [8, 10].

Methods

Study Population

Children and adolescents aged 7-15 years from four schools (two primary schools and two junior high schools chosen from 35 primary schools and 47 junior high schools using cluster random sampling; 39 classes) of Chengdu, South China were recruited in 2013 and invited to participate in the cross-sectional study "Diet Quality During Childhood", which aimed to obtain information on the diet, anthropometry and life style (e.g., physical activity). The survey aimed to recruit children representative of Southwest China. The study was approved by the Ethics Committee of Sichuan University. All parents gave written informed consent and children participated in the study voluntarily.

Initially, 2043 children and adolescents were recruited. Of these, 259 children with incomplete nutritional data (missing data on 24-hour recalls or eating behavior questionnaire, which influenced the calculation of the CCDI) and further 65 children who provided diet records with implausible energy intakes [37] were excluded. Thus, this analysis is based on a final sample of 1719 participants.

Diet Assessment

Data on dietary intake and eating behavior were collected in face-to-face interviews. In the interview, children older than eight years were asked to recall all foods and beverages consumed and the corresponding timing for the preceding 24 hours. Additionally, the interview included a questionnaire about eating behaviors. For children younger than nine years, parents provided the information on food consumption at home while children provided the dietary intake information from school themselves.

Dietary data was collected on three randomly chosen days within a 10-day period by trained investigators using 24-hour recalls (1% of the sample had two recalls; 82% had one weekend day and two weekdays, and the others had three weekdays). Weekdays (72.4%) and weekend days (27.6%) were proportionally distributed in study participants. Information on recipes and the types and brands of all food items reported was obtained. Standard serving bowls, plates and glasses were used to improve the accuracy of the portion size estimates; more than 150 food models for foods commonly consumed by Chinese children and adolescents were provided to help clarify the food items reported. In addition, study respondents were given a photo book containing photos of snacks and beverages, including the names of snacks and beverages as well as the picture of the commonly used commercial packaging (e.g. 1 carton) to improve the diet recall. In total, approximately 100 food items were represented in this photo book.

Dietary intake data from 24-hour recalls was converted into nutrient intake data using the continuously updated in-house nutrient database based on the software NCCW (version 11.0, 2014, Qingdao University Medical College), which reflected the China Food Composition [38]. This nutrient database includes any food item ever recorded in previous analysis [39] of our institute. Values are based on information from standard nutrient tables (e.g. rice) or product labels (e.g. most convenience foods). Missing nutrient data for foods (usually new commercial food products and convenience food items) are added to the database by the dietitian via a recipe which is simulated from the ingredients listed on the label or substituted by data from other national food tables, predominantly from Japan. Currently, the database contains information on energy and 36 nutrients for more than 1527 entries (944 basic food items, 562 food products, and 21 dietary supplements). Mixed dishes were disaggregated as separate food items (e.g. dumpling (pork) contributed toward wheat flour and pork components). For this analysis, dietary components of importance in school-aged children, those identified in the key recommendations of the Chinese dietary intake recommendations, were selected: total energy intake and intakes of protein, fat, carbohydrate, dietary fiber, vitamin A, vitamin C, vitamin E, thiamin, riboflavin, niacin, calcium, iron, phosphorous, zinc, magnesium, potassium, saturated fatty acids (SFA), monounsaturated, and polyunsaturated fatty acids (MUFA and PUFA). Values were calculated for each child as 3-day averages. In addition, the daily consumption of grains, whole grains, vegetables, fruits, dairy and dairy products, soybeans and its products, meat, eggs, fish and shrimp, water (including drinking

water, mineral water, tea and herbal tea) and sugar-sweetened beverages (SSBs) were calculated. SSBs were defined as beverages with added sugar, such as lemonades, fruit drinks (diluted and sugar-sweetened fruit juices), ice teas, soft drinks (soda pop), sports drinks, tea and coffee drinks, and sweetened milks. Juices made from 100% fruit were not classified as SSBs.

Eating behaviors relevant to the diet quality of children and adolescents were investigated using a questionnaire, including whether participants often eat breakfast (at least five days per week) or have dinner with parents regularly (at least five days per week) and the frequency of fried food consumption. The definition of fried foods included fried chicken, potato chips, corn chips, rice chips, instant noodles, fried dough bars and all other foods that were deep fried. The frequency of fried foods consumption per week was calculated for each participant.

Inactivity and additional information

In order to consider energy balance, participants were asked to report the usual time spent on sedentary behaviors on weekdays and on weekends, i.e. watching television, using computers and doing homework. Based on these data, total average hours of inactivity per day were calculated for each child.

In addition, one questionnaire on children's birth characteristics and socio-demographic data was completed by parents, providing information on birth weight, family location, household income, parental education levels, and family size. Participants' standing height and weight were measured by the trained interviewers to

the nearest 0.1 cm and 0.1 kg respectively using an ultrasonic Weight and Height Instrument (DHM-30, Dingheng Ltd, Zhengzhou, China). Body Mass Index (BMI) was calculated as weight/height^2 (kg/m^2). BMI Standard Deviation Score (BMI-SDS) were calculated based on the Chinese reference curves [40].

CCDI Component Selection

The CCDI was developed to rate diet quality in school-aged children by scoring their nutritional intakes in relation to current Chinese dietary intake recommendations (Chinese Dietary Guidelines 2007 [35] and Chinese DRIs 2013 [36]) and health-promoting behaviors, i.e. the CCDI is based on the combination of nutrients, foods/food-groups and the presence or absence of health-promoting behaviors. The CCDI consists of 16 components, and the criteria for the scoring of each component are shown in **Table 1**.

The first eight components of the CCDI score indicate the quality of food consumption expressed as food density (g/1000kcal). The intake of each food (grains, vegetables, fruits, dairy and dairy products, soybean and its products, fish and shrimp, meat and eggs) was compared to the recent age- and sex-specific dietary reference values [35] issued by Chinese Dietary Guidelines, so that the extent to which the intake recommendations were met was reflected by a calculated corresponding proportional point allocation.

SSBs consumption has been reported to be negatively associated with diet quality among children [41]. The current Chinese Dietary Guidelines suggest to “drink water sufficiently every day and choose beverages rationally”[35], however, Chinese

children and adolescents tend to have a high intake of sugar-sweetened beverages [42]. Therefore, drinking water and SSBs consumption were both included as 9th and 10th components in the CCDI.

The 11th to 13th components reflect the extent to which a child meets the existing nutritional recommendations for particular nutrients. Since vitamin A deficiency might increase children's susceptibility to infection, reduce physical growth and decrease the possibility of survival from serious illness [43], vitamin A was thus included; the cut-off value was derived from the recent age- and sex-specific dietary reference values [36]. According to the Healthy Eating Index (HEI), the ratio of unsaturated fatty acids (UFA) to SFA was used to capture the relative balance of these two categories of fatty acids[7]. Since the beneficial influence of fiber intake on constipation, obesity and diabetes is considerable, the increase children's dietary fiber consumption should be encouraged [44]. According to the current recommendations for dietary fiber [45-47], 14g/1000 kcal fiber was chosen for maximal score in this study.

Diet variety is a considerable factor for healthy diets [34 48]. Five major food groups (grains, vegetables, fruits, dairy/beans and meat/poultry/fish/eggs) were chosen to measure diet variety. Daily consumption of at least one serving from each of the five groups (definition of one serving: 25g for grains, 260g for vegetables, 200g for fruits, 160g for dairy, 25g for beans and 50g for meat) was chosen to achieve full points for this component.

Other eating behaviors related to childhood health were considered since eating breakfast or having dinner with parents have been suggested to be associated

196 with lower risk of childhood overweight/obesity [49-51]. Eating breakfast and having
197 dinner with parents regularly comprised the 15th component of the CCDI.

198 The last component of CCDI is a reflection of energy balance, as previously
199 considered in the Revised Children's Diet Quality Index (RC-DQI) [10]. Energy intake
200 was calculated from the 24h-recalls and energy expenditure was calculated based on
201 the information provided about sedentary behaviors.

202

203 **Scoring of the CCDI**

204 The scoring scheme of the CCDI is based on the premise that children who consume
205 appropriate amounts and types of nutrients or foods and engage in health-promoting
206 behaviors [35 36] receive full points for each component. The point allocation of each
207 component is reduced, if necessary, proportionally according to the deviation from the
208 ideal. Thus, the CCDI measures over- as well as under-consumption.

209 For vegetables, fruits, dairy and dairy products, soybeans and its products, fish
210 and shrimp, and dietary fiber, the lowest recommended intake per 1000 kcal (i.e. the
211 easiest goal to achieve in Chinese Dietary Guidelines [35]) was chosen as the standard
212 for the maximum score for each of these adequacy components. Daily consumption at
213 the standard level or above was assigned 10 points. If the reported intake was lower
214 than the recommended intake level, scores were calculated by dividing the reported
215 intake by the recommended level and then multiplying with the maximum score. For
216 example, children who consumed 150g/1000kcal vegetables of the recommended
217 175g/1000kcal, received a score of 8.6 in the vegetable component ((150/175)*10=8.6

points).

For grains, meat and eggs, i.e. foods that should be consumed moderately [35], scores were calculated using (1- | 1- (reported intake/recommended intake) |)*maximum score, if the reported intake was not within the recommended range. For instance, children who consumed 200g/1000kcal grains (140-160g/1000kcal were recommended) received 7.5 points [(1- | 1-(200/160) |)*10=7.5 points].

For vitamin A, fatty acids and water, i.e. those factors that should not fall below the recommended level, the maximum score was assigned if the daily intake reached or exceeded the level of Recommended Nutrient Intakes (RNI)/Adequate Intakes (AI). When the reported intake was lower than the RNI/AI, scores were calculated by dividing the reported intake by the recommended intake and multiplying with the maximum score.

For SSBs, consumption should be limited. The score was calculated by (1-(reported intake/250))*10 points if the intake was below 250 ml (one serving) per day. For example, children consuming 150 ml of SSBs would receive 4 points [(1-(150/250))*10=4 points]. A score of 10 was given if SSBs intake was 0 ml/d; the score declined to 0 when SSBs intake was more than 250 ml/d.

For diet variety, consumption of at least one serving of food per day from each of the five food groups (grains, vegetables, fruits, dairy/beans and meat/poultry/fish/eggs) was given 10 points. To provide equal weighting of each of the five food groups, daily intake of any of these food groups of less than one serving, resulted in a reduction of 2 points for each food group.

Children received 5 points for eating breakfast or having dinner with parents regularly, respectively. Zero points were given if they neither ate breakfast nor had dinner with parents regularly.

The CCDI score for energy balance was calculated based on two sub-scores a) the 3-day average energy intake and b) sedentary behaviors. To reflect the appropriate energy intake (no over- or under-consumption), children who consumed within 10% of the ideal energy intake (0.9-1.1 estimated energy requirements (EER)) [36] received 10 points. Scores for suboptimal energy intake or over-consumption were reduced proportionally. For sedentary behaviors, children who spent less than 1 hour/day [10] or more than 6 hours/day [52] on sedentary behaviors received 10 or 0 points, respectively. The score was reduced proportionally, if the time spent for sedentary behaviors was between 1 and 6 hours/day. The score for the component "energy balance" was calculated as mean value of the two sub-scores.

All components of the CCDI were assumed to have equal effect on children's health and contributed 0-10 points. Thus, the total CCDI scores ranged from 0 to 160, with a higher score indicating better agreement with the recommendations and therefore better diet quality.

Statistical Analysis

All statistical analyses were carried out with SAS software (version 9.3, 2011, SAS Institute Inc., Cary, NC, USA.). A p value<0.05 was considered statistically significant. Values reported are means ± standard deviation (SD) for variables

normally distributed or medians (25^{th} percentile, 75^{th} percentile) for those not normally distributed.

The total CCDI scores were normally distributed. Student *t* test and analysis of variance were used to test differences of the total CCDI scores between sexes and different age groups, respectively. To characterize the diet quality of the sample, the continuous total CCDI scores were divided into quartiles to create three categories: lower ($<25^{th}$ percentile), moderate ($\geq25^{th}$ percentile and $\leq75^{th}$ percentile) and higher ($>75^{th}$ percentile) diet quality. To test the association between CCDI scores and important indicators of diet quality, which were not included in the index, the Pearson or Spearman correlations were used to assess the correlations between the total CCDI score and age, BMI, inactivity, whole grain, frequency of fried foods and nutrient adequacy ratios (calculated for each nutrient as the ratio of daily intakes to recommended amount of nutrient based on the 2013 Chinese DRIs) [36].

Finally, to indicate if social-economic factors were correlated with the CCDI, a stepwise multiple regression analysis of the data was performed. Variables for the stepwise linear regression model were selected based on univariate correlation analyses and variables that are known or thought to be associated with diet quality from published observations, such as gender, paternal education level, maternal education level, family income level and family size[2].

Results

General characteristics of the study sample are shown in **Table 2**. Half of the children

in this study were girls, and the mean age was 10.3 years. Children had a moderate socio-economic status. The average CCDI score of the participants was 88.1±15.4, ranging from 34.2 to 137.8 points of the maximum of 160 points (data not shown). The diet quality of girls (mean CCDI score 91.1±15.1) was higher than that of boys (85.1±15.2) ($p<0.0001$).

Among the 16 components of CCDI, the highest mean sub-scores were observed for SSBs, fatty acids, breakfast and dinner components (8.8 for SSBs, 10.0 for fatty acids, 10.0 for breakfast and dinner), and more than half of the children met the intake recommendations for these three components (**Table 3**). However, scores for grains, soybeans, meat, fish and shrimp, eggs and dietary fiber were much lower (≤3 points), reflecting excessive grains and meat consumption and inadequate consumption of soybeans, fish and shrimp, eggs and dietary fiber. More than 60% of the study sample consumed vegetables and fruits below the recommendations issued by Chinese Dietary Guidelines; the mean sub-scores for vegetables and fruits were 4.6 and 6.3, respectively.

Table 4 shows age, BMI, inactivity, foods/food groups and nutrient adequacy ratios in relation to the CCDI score. Children with a higher CCDI score were younger, had lower BMI and spent less time on inactivity. Significant and positive correlations of the CCDI with the majority of nutrient adequacy ratios and the mean adequacy ratio (MAR) were observed (Pearson or Spearman correlation coefficients ranging from 0.08 to 0.47), which indicated that increasing CCDI scores reflected higher overall diet quality. However, whole grain intake and frequency of fried foods were

not significantly associated with the CCDI score.

In general, gender, age, BMI-SDS, paternal educational level, maternal educational level, family size and family income level were selected as explanatory variables for the stepwise linear regression model. Significant predictors were introduced in three steps into the linear regression model with stepwise method. Age was entered as the first step that explained 49% of the variation. In the step 2, age and paternal educational level were entered in the model, which explained 58% of the variation. In the final model (step 3), age, paternal educational level and family size were entered in the regression model that now explained 83% of variation in this sample. Coefficients of the regression model are presented in **Table 5**.

Discussion

In this study, a dietary index was developed to evaluate overall diet quality specific to the needs of Chinese school-aged children. The CCDI was formulated based on the updated Chinese Dietary Guidelines (2007 version) [35] and DRIs (2013 version) [36]. It incorporated nutrients and foods/food-groups along with several health-promoting behaviors. The CCDI score was observed to be related not only to the foods/food-groups and nutrients incorporated into the index, but also to other essential nutrients such as protein, calcium, magnesium, potassium, vitamin C, vitamin E and riboflavin. These correlation coefficients were consistent with diet indices developed for children in western countries [8, 16, 24] and in Indian vegetarian girls [33]. These results revealed that the CCDI can be used as a valuable tool to assess the overall diet quality among Chinese children and adolescents.

Compared with the HEI [8], Youth Healthy Eating Index (YHEI) [8] and Adolescent Micronutrient Quality Index (AMQI) [33], the correlation of the CCDI with total energy intake was lower. In addition, our results showed that the CCDI was correlated negatively with inactivity level, which was in line with HEI, YHEI and AMQI. The association between YHEI and inactivity was the strongest (r=-0.27) among these indices.

In this study, socio-economic factors correlated with CCDI were also identified. Children of younger ages had better diet quality, which is consistent with the existing dietary indices [8, 17, 19, 20, 53, 54]. Interestingly, this study revealed an impact of paternal, rather than maternal, education level on the child's diet quality. Moreover, diet quality of children from households where both parents have a high level of education was higher than those from household where both parents do not have a high level education (their total CCDI scores were 92.4 and 87.9, respectively). This may be based on the fact that Chinese fathers play an important role in the family and exert great influence on eating patterns through their behaviors and attitudes [55]. In addition, a positive association between CCDI score and family size was observed. The reason for this was likely that in the traditional Chinese family, children often live with their parents and grandparents. Grandparents usually have more time to prepare family meals in the three-generation family, compared to parents who were busy working and are having to prepare meals in the two- generation family [51]. On the other hand, this study found that 86% of participants received full points (10 points) for eating breakfast and for having dinner with parents, whereas their sub-scores for other components of CCDI were not that high. This seems to indicate that eating meals with parents does not always translate into a good quality diet. However, this was emphasized in current Chinese dietary recommendations and thus were kept in

the index. These findings suggest that further studies focused on Chinese children need to investigate the relationship between dinner with grandparents and diet quality.

The CCDI was used to evaluate the overall diet quality of study participants. Results from this sample indicated that the diet quality of Chinese children and adolescents may need to be improved, especially in adolescents. It was remarkable that the component scores measuring intakes of grains, soybeans, meat, eggs, fish and shrimp were low, indicating general overconsumption of grains and meat and under-consumption of soybeans, eggs, fish and shrimp. In addition, the lower overall diet quality of study participants could be partially attributed to lower intakes of vegetable, fruit, soybean, eggs, fish and shrimp. These findings were consistent with other observational studies, which have suggested that the intakes of vegetables [56, 57], fruit [56, 57] and soybeans [57] in Chinese children and adolescents were much lower than the recommended intake levels, while the consumption of fried foods increased rapidly [58]. The intake patterns observed in this study reflect the "Westernization of diet" [59], which has been shown to be associated with higher risk for chronic diseases.

Compared with dietary indices for children in developed countries [60], the CCDI is the only scoring system that includes the evaluation of both healthful and unhealthful foods/food-groups and nutrients as well as health-related behaviors. Thus the CCDI incorporates the interactions of nutrients and foods/food-groups. Another strength of the CCDI lies in the fact that it was developed not only for younger children but also for adolescents, as the CCDI is based on recommendations that consider the energy requirements according to age and gender [36].

Some limitations should be mentioned. The non-representativeness of this sample for Chinese children in general may have decreased the statistical power of the findings, however, no or just minor differences were found in social class

(characterized by income in the household, parental education level and parental profession) between participants in this study and those in national surveys [61, 62]. Indeed, comparisons of the dietary data in the present study with a population-based survey, China Health and Nutrition Survey (CHNS), did not indicate major differences in nutrient intakes or general eating behavior [63-65]. Secondly, although dietary data was collected on weekday and weekend days during a 10-day period, not all seasons were captured. Seasonal effect might exist when assessing diet quality for children. In addition, there might be misreporting of dietary intake for children and adolescents [66]. Factors related to the accuracy of dietary reporting among children should be taken into consideration, such as the timing of interview [66]. Finally, the use of bio-markers for vitamin C, cholesterol, iron, calcium or zinc would have been preferable to increase the validity of the CCDI. However, as in most large observational studies, inclusion of blood or urine sampling is difficult, especially in children and adolescents.

Conclusions

The CCDI successfully differentiated diets by level of diet quality and can be used to determine the overall diet quality among Chinese children and adolescents. Results of this study indicated that the diet quality among children in South China needs to be improved, especially in adolescents. Further research is needed to apply the CCDI to more diverse Chinese school-aged populations, whose dietary patterns may be different from the population of the present study, and to evaluate the relevance of diet quality in childhood on potential indicators for health and disease.

References

1. Schwingshackl L, Hoffmann G. Diet Quality as Assessed by the Healthy Eating Index, the Alternate Healthy Eating Index, the Dietary Approaches to Stop Hypertension Score, and Health Outcomes: A Systematic Review and Meta-Analysis of Cohort Studies. Journal of the Academy of Nutrition and Dietetics. 2015;115:780-800 e785.
2. Marshall S, Burrows T, Collins CE. Systematic review of diet quality indices and their associations with health-related outcomes in children and adolescents. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2014;27:577-598.
3. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. Current opinion in lipidology. 2002;13:3-9.
4. Cox DR, Skinner JD, Carruth BR, Moran J, 3rd, Houck KS. A Food Variety Index for Toddlers (VIT): development and application. Journal of the American Dietetic Association. 1997;97:1382-1386; quiz 1387-1388.
5. Kennedy ET, Ohls J, Carlson S, Fleming K. The Healthy Eating Index: design and applications. Journal of the American Dietetic Association. 1995;95:1103-1108.
6. Guenther PM, Reedy J, Krebs-Smith SM. Development of the Healthy Eating Index-2005. Journal of the American Dietetic Association. 2008;108:1896-1901.
7. Guenther PM, Casavale KO, Reedy J, et al. Update of the Healthy Eating

Index: HEI-2010. Journal of the Academy of Nutrition and Dietetics. 2013;113:569-580.

8. Feskanich D, Rockett HR, Colditz GA. Modifying the Healthy Eating Index to assess diet quality in children and adolescents. Journal of the American Dietetic Association. 2004;104:1375-1383.

9. Kranz S, Siega-Riz AM, Herring AH. Changes in diet quality of American preschoolers between 1977 and 1998. American journal of public health. 2004;94:1525-1530.

10. Kranz S, Hartman T, Siega-Riz AM, Herring AH. A diet quality index for American preschoolers based on current dietary intake recommendations and an indicator of energy balance. Journal of the American Dietetic Association. 2006;106:1594-1604.

11. Fulgoni VL, 3rd, Keast DR, Drewnowski A. Development and validation of the nutrient-rich foods index: a tool to measure nutritional quality of foods. The Journal of nutrition. 2009;139:1549-1554.

12. Zimmer MH, Hart LC, Manning-Courtney P, Murray DS, Bing NM, Summer S. Food variety as a predictor of nutritional status among children with autism. Journal of autism and developmental disorders. 2012;42:549-556.

13. Falciglia GA, Troyer AG, Couch SC. Dietary variety increases as a function of time and influences diet quality in children. Journal of nutrition education and behavior. 2004;36:77-83.

14. Spence AC, McNaughton SA, Lioret S, Hesketh KD, Crawford DA, Campbell

KJ. A health promotion intervention can affect diet quality in early childhood. The Journal of nutrition. 2013;143:1672-1678.

15. Scott JA, Chih TY, Oddy WH. Food variety at 2 years of age is related to duration of breastfeeding. Nutrients. 2012;4:1464-1474.

16. Marshall S, Watson J, Burrows T, Guest M, Collins CE. The development and evaluation of the Australian child and adolescent recommended food score: a cross-sectional study. Nutrition journal. 2012;11:96.

17. Golley RK, Hendrie GA, McNaughton SA. Scores on the dietary guideline index for children and adolescents are associated with nutrient intake and socio-economic position but not adiposity. The Journal of nutrition. 2011;141:1340-1347.

18. Li J, O'Sullivan T, Johnson S, Stanley F, Oddy W. Maternal work hours in early to middle childhood link to later adolescent diet quality. Public health nutrition. 2012;15:1861-1870.

19. Kleiser C, Mensink GB, Scheidt-Nave C, Kurth BM. HuSKY: a healthy nutrition score based on food intake of children and adolescents in Germany. The British journal of nutrition. 2009;102:610-618.

20. Kleiser C, Mensink GB, Neuhauser H, Schenk L, Kurth BM. Food intake of young people with a migration background living in Germany. Public health nutrition. 2010;13:324-330.

21. Alexy U, Sichert-Hellert W, Kersting M, Lausen B, Schoch G. Development of scores to measure the effects of nutrition counselling on the overall diet: A

pilot study in children and adolescents. European journal of nutrition. 1999;38:196-200.

22. Kohlboeck G, Sausenthaler S, Standl M, et al. Food intake, diet quality and behavioral problems in children: results from the GINI-plus/LISA-plus studies. Annals of nutrition & metabolism. 2012;60:247-256.

23. Kurt Gedrich, Karg G. Dietary habits of german vs non-german residents in germany. Culinary Arts and Sciences III – Global and National Perspectives. 2001:419-428.

24. Kyttala P, Erkkola M, Lehtinen-Jacks S, et al. Finnish Children Healthy Eating Index (FCHEI) and its associations with family and child characteristics in pre-school children. Public health nutrition. 2013:1-9.

25. Serra-Majem L, Ribas L, Ngo J, et al. Food, youth and the Mediterranean diet in Spain. Development of KIDMED, Mediterranean Diet Quality Index in children and adolescents. Public health nutrition. 2004;7:931-935.

26. Royo-Bordonada MA, Gorgojo L, Ortega H, et al. Greater dietary variety is associated with better biochemical nutritional status in Spanish children: the Four Provinces Study. Nutrition, metabolism, and cardiovascular diseases : NMCD. 2003;13:357-364.

27. Mariscal-Arcas M, Romaguera D, Rivas A, et al. Diet quality of young people in southern Spain evaluated by a Mediterranean adaptation of the Diet Quality Index-International (DQI-I). The British journal of nutrition. 2007;98:1267-1273.

28. Glanville NT, McIntyre L. Diet quality of Atlantic families headed by single mothers. Canadian journal of dietetic practice and research : a publication of Dietitians of Canada = Revue canadienne de la pratique et de la recherche en dietetique : une publication des Dietetistes du Canada. 2006;67:28-35.

29. Woodruff SJ, Hanning RM. Development and implications of a revised Canadian Healthy Eating Index (HEIC-2009). Public health nutrition. 2010;13:820-825.

30. Kennedy GL, Pedro MR, Seghieri C, Nantel G, Brouwer I. Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. The Journal of nutrition. 2007;137:472-477.

31. Darapheak C, Takano T, Kizuki M, Nakamura K, Seino K. Consumption of animal source foods and dietary diversity reduce stunting in children in Cambodia. International archives of medicine. 2013;6:29.

32. Rah JH, Akhter N, Semba RD, et al. Low dietary diversity is a predictor of child stunting in rural Bangladesh. European journal of clinical nutrition. 2010;64:1393-1398.

33. Chiplonkar SA, Tupe R. Development of a diet quality index with special reference to micronutrient adequacy for adolescent girls consuming a lacto-vegetarian diet. Journal of the American Dietetic Association. 2010;110:926-931.

34. Mirmiran P, Azadbakht L, Esmaillzadeh A, Azizi F. Dietary diversity score in adolescents - a good indicator of the nutritional adequacy of diets: Tehran lipid

and glucose study. Asia Pacific journal of clinical nutrition. 2004;13:56-60.

35. Ge K. The transition of Chinese dietary guidelines and food guide pagoda. Asia Pacific journal of clinical nutrition. 2011;20:439-446.

36. Chinese Nutrition Society. Dietary Reference Intakes for Chinese (Version 2013). Beijing: Science Press; 2014.

37. Schofield WN. Predicting basal metabolic rate, new standards and review of previous work. Human nutrition. Clinical nutrition. 1985;39 Suppl 1:5-41.

38. YANG Yue-xin HM, PAN Xing-chang. China Food Composition. 2nd ed. Peking University Medical Press.2004.

39. Duan RN, Liu Y, Xue HM, Yang MZ, Cheng G. Cross-sectional association between overall diet quality and overweight/obesity among children and adolescents in Chengdu. Chinese Journal of Epidemiology. 2014;35:994-997.

40. Li H, Ji CY, Zong XN, Zhang YQ. [Body mass index growth curves for Chinese children and adolescents aged 0 to 18 years]. Zhonghua er ke za zhi. Chinese journal of pediatrics. 2009;47:493-498.

41. Libuda L, Alexy U, Buyken AE, Sichert-Hellert W, Stehle P, Kersting M. Consumption of sugar-sweetened beverages and its association with nutrient intakes and diet quality in German children and adolescents. The British journal of nutrition. 2009;101:1549-1557.

42. Shang XW, Liu AL, Zhang Q, et al. Report on childhood obesity in China (9): sugar-sweetened beverages consumption and obesity. Biomedical and environmental sciences : BES. 2012;25:125-132.

536 **43.** Jiang J, Toschke AM, von Kries R, Koletzko B, Lin L. Vitamin A status among
537 children in China. Public health nutrition. 2006;9:955-960.
538 **44.** Kranz S, Brauchla M, Slavin JL, Miller KB. What do we know about dietary
539 fiber intake in children and health? The effects of fiber intake on constipation,
540 obesity, and diabetes in children. Advances in nutrition (Bethesda, Md.).
541 2012;3:47-53.
542 **45.** (AAP) AAoP. Carbohydrate and dietary fiber.1993.
543 **46.** Williams CL, Bollella M, Wynder EL. A new recommendation for dietary
544 fiber in childhood. Pediatrics. 1995;96:985-988.
545 **47.** Io M. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids,
546 cholesterol, protein and amino acids (Macronutrient). 2002.
547 **48.** Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J. The
548 effects of variety in food choices on dietary quality. Journal of the American
549 Dietetic Association. 1987;87:897-903.
550 **49.** Xue Y, Yun C, Zhao A, Wang P, Zhang Y, Mu Z. [Effect of poor dietary
551 behaviors on the overweight and obesity of school-aged children]. Wei Sheng
552 Yan Jiu. 2014;43:764-767.
553 **50.** Li YP, Hu XQ, Ma WJ, Ma GS. [The Relationship Between Breakfast
554 Frequency and Obesity Prevalence Among Four Cities in China]. Chin J
555 School Health. 2005;26:10-12.
556 **51.** Jiang J, Rosenqvist U, Wang H, Greiner T, Lian G, Sarkadi A. Influence of
557 grandparents on eating behaviors of young children in Chinese

three-generation families. Appetite. 2007;48:377-383.

52. Wang C, Chen P, Zhuang J. A national survey of physical activity and sedentary behavior of Chinese city children and youth using accelerometers. Research quarterly for exercise and sport. 2013;84 Suppl 2:S12-28.

53. Kranz S, Findeis JL, Shrestha SS. Use of the Revised Children's Diet Quality Index to assess preschooler's diet quality, its sociodemographic predictors, and its association with body weight status. Jornal de pediatria. 2008;84:26-34.

54. de Andrade SC, de Azevedo Barros MB, Carandina L, Goldbaum M, Cesar CL, Fisberg RM. Dietary quality index and associated factors among adolescents of the state of Sao Paulo, Brazil. The Journal of pediatrics. 2010;156:456-460.

55. Chen YP, Wang HM, Edwards TC, et al. Factors influencing quality of life of obese students in hangzhou, china. PloS one. 2015;10:e0121144.

56. Wang ZH, Zhang B, Wang HJ, et al. [Trend in vegetable and fruit intake among Chinese children and adolescents aged 6 to 17 years from 1991 to 2009 and related socio-demographic factors]. Zhonghua liu xing bing xue za zhi = Zhonghua liuxingbingxue zazhi. 2013;34:863-868.

57. Zhang CX, Chen YM, Chen WQ, Su YX, Wang CL, Wu JN. Food group intake among adolescents in Guangzhou city compared with the Chinese dietary guidelines. Asia Pacific journal of clinical nutrition. 2012;21:450-456.

58. Wang Z, Zhai F, Du S, Popkin B. Dynamic shifts in Chinese eating behaviors. Asia Pacific journal of clinical nutrition. 2008;17:123-130.

59. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a

diet linked with noncommunicable diseases. The American journal of clinical nutrition. 2006;84:289-298.

60. Lazarou C, Newby PK. Use of dietary indexes among children in developed countries. Advances in nutrition (Bethesda, Md.). 2011;2:295-303.

61. He L, Zhai Y, Engelgau M, et al. Association of children's eating behaviors with parental education, and teachers' health awareness, attitudes and behaviors: a national school-based survey in China. European journal of public health. 2013.

62. National Bureau of Statistics of China. National Data. 2014. Available at: http://data.stats.gov.cn/workspace/index?m=hgnd. (accessed 2014).

63. Cui Z, Dibley MJ. Trends in dietary energy, fat, carbohydrate and protein intake in Chinese children and adolescents from 1991 to 2009. The British journal of nutrition. 2012;108:1292-1299.

64. Du SM, Pan H, Hu XQ, et al. [Water intake of primary and middle school students in four cities of China]. Zhonghua yu fang yi xue za zhi [Chinese journal of preventive medicine]. 2013;47:210-213.

65. Zhang J, Wang HJ, Wang ZH, et al. [Trend in dietary calcium intake among Chinese children and adolescents aged 4 to 17 years in nine provinces from 1991 to 2009]. Zhonghua liu xing bing xue za zhi = Zhonghua liuxingbingxue zazhi. 2013;34:857-862.

66. Sharman SJ, Skouteris H, Powell MB, Watson B. Factors Related to the Accuracy of Self-Reported Dietary Intake of Children Aged 6 to 12 Years

602 Elicited with Interviews: A Systematic Review. Journal of the Academy of
603 Nutrition and Dietetics. 2015.