Dietary pattern and its' association with anemia among infants aged 6-23 months in central-south China.

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Research article

Keywords: Dietary pattern, Anemia, Infant

Posted Date: November 18th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-20064/v2

Version of Record: A version of this preprint was published at BMC Public Health on April 9th, 2021. See the published version at https://doi.org/10.1186/s12889-021-10699-8.

Abstract

Backgroud: Anemia is widely prevalent among children, and this study aims to understand dietary patterns and its' association with anemia.

Methods: A cross-sectional design in two time period was conducted at Mayang in 2015 and in 2018. The diet data was collected by questionnaire, and dietary patterns were identified by exploratory factor analysis. Hemoglobin (Hb) was measured to assess the status of anemia. The association between the dietary patterns and anemia was assessed by the logistic regression model.

Results: The mean age of infants were 14.06 months in 2015 and 16.58 months in 2018. Four dietary patterns were identified among infants aged 6-23 months in central-south China. Diversified pattern: mainly tubers, dairy products, bean and bean products; traditional pattern:mainly cereals, water and soup, and other vegetables and fruits; breast milk pattern: mainly breast milk but less powered formulas; and multi-nutrient powders pattern: mainly multi-nutrient powders. The prevalence of anemia among infant reduced from 29.49% in 2015 to 20.26% in 2018. The top quartile (Q4) of diversified pattern and multi-nutrient powders pattern deminished the risk of anemia by 45% (OR = 0.55, 95% CI: 0.30 to 0.99, P = 0.047) and 59% (OR = 0.41,95% CI: 0.22 to 0.78, P = 0.006) compared to the lowest quartile (Q1), while the breast milk pattern had a 3.26-fold greater risk of anemia than the lowest quartile (Q1) (OR = 3.26,95%CI:1.83 to 5.81, P <0.001).

Conclusions: Four dietary patterns were identified among infants aged 6-23 months in central-south China. The pattern with a variety of food groups should be strengthened to improve anemia among infants.

Background

Anemia is widely prevalent among children, which has short- and long-term effects on health and development, such as increasing growth retardation, decreasing immunity and intelligence, and even having effects on children's adulthood health[1]. The study reported in 2011, 18.1% of children under five were suffering from anemia in the global [2]. In China, the prevalence of anemia was 12.6% among children under five in 2012, especially for children aged 6 to 23 months, there were 20.5% to 28.2% of those children suffering from anemia[3].

Infancy is the most vigorous period of children's growth and development, and the critical period of complementary feeding. The majority of studies had reported that insufficient intake of iron from diet is the most important reason of anemia in infancy[4-6]. In addition, some studies also reported that the interaction between different foods impacted on absorption of iron, is one of reasons for anemia. For example, the iron from plant food has a lower absorption rate because the phytic acid and oxalic acid in plant food can form insoluble combination and reduce the absorption rate of iron[1]. However, most of researchers focused on the association of individual food or nutrient with anemia among infants in

previous studies[4], and neglected the potential interactions between total dietary intake and foods or nutrients.

The dietary patterns analysis, based on the complex source of diet and the total dietary consumption, is becoming a popular analytical method to evaluate the associations between diet and their impact on health[7, 8]. The previous study from Singapore reported that four dietary patterns labeled Predominantly breast milk, Guidelines, Easy-to-prepare foods, and Noodles and seafood are observed among infant aged 6- to 12-months[9]. And other studies also shown that the dietary patterns among infants have association with weight[10], caries[11], bone mass[12], and intelligence quotient[13]. But few studies clarified dietary patterns relate to anemia of infant.

In this study, we aim to :1) identify the dietary patterns among infants aged 6-23 months in central-south China; 2) clarify the association of dietary patterns with anemia.

Methods

Study design

A cross-sectional design based on community in two time period was conducted at Mayang in 2015 and in 2018. The Mayang was a minority nationality autonomous county, located in central-south of China. The county consisted of 18 towns or communities and the total birth numbers were 4698 in 2015 and 3988 in 2018.

The population of this study consisted of caregivers with children aged 6 to 23 months, involving the five towns or communities of the Mayang. The sample size was calculated by the following formula:

$$n = \frac{u^2{}_{\alpha/2}\pi(1-\pi)}{\sigma^2}$$

According to the Report of Nutrition Development for Children Aged 0-6 in China[3], the prevalence of anemia among children aged 6 to 23 months was approximately 25%. In this study, $\pi=0.25$, $\sigma=5\%$, $\alpha=0.05$, $n\approx290$. The sample size increased to 300 considering the missing of objectives.

The total of 312 and 311 children aged 6 to 23 months were recruited in 2015 and in 2018 by multistage sampling technique. For first time period, five towns or communities were firstly selected at random in Mayang according to the total number of birth last year. Secondly, five villages were randomly selected in each town or community according to the total number of birth last year. The total of 25 villages was selected. Lastly, the proportional allocation method was performed based on the total number of children aged 6-23 months.10 to 15 children aged 6 to 23 months were randomly selected in each village lining up to children's age. The second time period was conducted in 2018. The participants and method of

sampling were consistent with the first time period. The number of birth was from maternal and child annual health report of Mayang.The information of infants age 6 to 23 months was from local maternal and child health care system.

Dietary data

The questionnaires were asked for caregivers about children's consumption in the previous 24h, which had been reported by our previous study[14]. Total of 15 types of foods were recorded according to guide to infant feeding and nutrition of China[15] in this study. These foods included: breast milk, powered formulas, milk powder and fresh milk, water and soup, sugar water and drink, cereals, tubers, dark leaf vegetables and fruits, other vegetables and fruits, meat, egg, dairy products, bean and bean products, nut and multi-nutrient powders. The frequency of breast milk, powered formulas, milk powder, fresh milk and multi-nutrient powders were recorded in previous 24h, and other foods were recorded as yes or no (0=no and 1=yes).This food list was similar in both time period of survey. The questionnaires of dietary data collection were implemented through interviews by trained investigators.

Dietary patterns analysis

An exploratory factor analysis was performed to identify dietary patterns. To understand the dietary patterns from 2015 to 2018, we combined both data sets before running the exploratory factor analysis. Firstly, the frequency of 15 foods were included analysis. The Kaiser-Meyer-Olkin statistic was used to analyze the compliance of variables. Then the number of dietary patterns were identified based on the eigenvalue (>1) and screen plot, factor interpretability, and variance explained. The food with factor loadings of > |0.3| were considered to significantly contribute to the identified factors. Lastly, the standardized scores which represent the sum of intakes of food weighted by their factor loadings were calculated for each child. The higher factor score in each pattern indicated that the participant was more related to this dietary pattern. Factor scores were categorised into four quartiles (Q1 was weakly related to the dietary pattern; Q4 was strongly related to the food pattern)[16].

Dietary patterns assessment

World Health Organization infant and young child feeding indicators were used to assess the quality of dietary patterns[17]. Total 8 indicators were included in World Health Organization infant and young child feeding indicators. Definitions and parameters for child feeding associated with each indicator were used to disaggregate the data by the specified age groups. Children's age was in group of 6 to 23 months in our study; therefore, four evaluation indicators were used, including: minimum dietary diversity, minimum meal frequency, minimum acceptable diet, consumption iron-fortified food. Minimum dietary diversity: Children who received foods from 4 food groups during the previous day. Minimum meal frequency: Children who received solid, semi-solid or soft foods the minimum number of times or more during the previous day. Minimum acceptable diet: Children who received at least the minimum dietary diversity and the minimum meal frequency during the previous day. Consumption of iron-rich or iron-fortified food: Children who received an iron-rich food or a food that was specially designed for infants

and young children and was fortified with iron, or a food that was fortified at home with a product that included iron during the previous day.

Anemia assessment

The blood sample was collected by pricking children's fingers to obtain capillary blood. Hemoglobin (Hb) was measured by microchemical reaction method. The hemoglobin concentration was detected by using hemoglobin machine which made from Hemocue AB Company of Sweden with model hemocue 301.The result was expressed in g/dL. The cut off points for anemia were: for children aged 6 to 23 months, normal Hb levels≥11.0 g/dL, anemia<11.0 g/dL[18].

Other variables

Information about infant included: sex (boy or girl), age (6-11 months, 12-17 months and 18-23 months), birth weight (normal or low birth weight), gestational age (term or premature), fever and diarrhea in the previous 2 weeks (yes or no). Information about caregivers included: caregivers' groups (parents or grandparents and others), educational level (illiteracy, primary, junior, and senior and above), occupations(homemakers or others), and ethnicity (Han and others or Miao).These informations were collected by same questionnaire with dietary questionnaire.

Statistical analyses

The data were expressed as numbers and percentages for categorical variables.Significant differences were assessed by χ^2 .The association between the related factors and anemia was assessed using the logistic regression model. Firstly, the bivariate logistic regression analyse was performed to analysize the age, sex, birth weight, gestational age, episode of diarrhea or fever in the previous 2 weeks, and dietary patterns of children as well as caregivers' group, educational level, occupations, ethnicity. Then, factors with a value of $P \leq 0.10$ in bivariate analysis were included in the multivariable logistic regression model.Odds ratio (OR) with 95% confidence interval (CI)were calculated to determine the strength of associations. A value of $P < 0.05$ was considered indicative of statistical significance.All analyses were performed using Statistical Product and Service Solutions 13.

Results

The surveys in 2015 and 2018 included 312 and 311 children aged 6 to 23 months. The mean age of infants were 14.06 months in 2015 and 16.58 months in 2018. The table 1 shown the characteristics of infants and caregivers. Nearly 60% of infants were boys. Over 95% were normal birth weight and gestational age with term. About 85% of caregivers' ethnicity were Miao. Higher proportion (37.82%) of infants aged 6 to 11 months in 2015, while higher proportion of infants (44.69%) aged 17 to 23 months in 2018. The prevalence of fever and diarrhea in previous 2 weeks in 2015 were higher than that in 2018. Comparing to 2015, the proportion of parents as caregivers and the educational level of caregivers

increased in 2018, but the proportion of caregivers' occupation with homemakers decreased. In addition, the prevalence of anemia was higher in 2015 (29.49%) than 2018 (20.26%).

Table 2 shown that four dietary patterns were identified in infant aged 6 to 23 months accounting for 47.86 % of the explained variance. The pattern 1 included various foods, which was mainly characterized by high consumption frequency of tubers, dairy products, bean and bean products, nut, dark leaf vegetables and fruits, meat and egg, named as diversified pattern. The pattern 2 was positively correlated with intake of cereals, water and soup, other vegetables and fruits, meat, multi-nutrient powders, but negatively correlated with intake of milk powder and fresh milk, namely traditional pattern. The pattern 3 was associated with high intakes of breast milk, but low intakes of powered formulas, and milk powder and fresh milk, named as breast milk pattern. The pattern 4 had high positive loadings for multi-nutrient powders, sugar water and drink, powered formulas, and negative loadings for dark leaf vegetables and fruits, and cereals, named multi-nutrient powders pattern.

The infant and young child feeding indicators of World Health Organization by four quartiles of dietary patterns was listed in table 3. The children in the top quartile (Q4) of diversified pattern had higher rate of minimum dietary diversity (P<0.001) and minimum acceptable diet (P<0.001). The children in the top quartile (Q4) of traditional pattern had higher rate of minimum dietary diversity (P<0.001) , minimum acceptable diet (P<0.001), and consumption iron-fortified food (P<0.001). The children in the top quartile (Q4) of breast milk pattern had higher rate of minimum dietary diversity (P<0.05) ,minimum meal frequency (P<0.05) and minimum acceptable diet (P<0.05). However, the children in the top quartile (Q4) of multi-nutrient powders pattern had lower rate of minimum dietary diversity (P<0.05) , minimum meal frequency (P<0.05) and minimum acceptable diet (P<0.001), but higher rate of consumption iron-fortified food (P<0.001).

The result of the association between the related factors and anemia among infants by logistic regression model was described in Table 4. The risk of anemia in 2018 was decreased 14% compared to 2015 (OR = 0.86,95%CI:0.74 to 1.00, P = 0.047).The top quartile (Q4) of diversified pattern deminished the risk of anemia by 45%(OR = 0.55,95%CI:0.30 to 0.99, P = 0.047) compared to the lowest quartile (Q1). The multi-nutrient powders pattern in the top quartile (Q4) reduced the risk of anemia by 59%(OR = 0.41,95%CI:0.22 to 0.78, P = 0.006) compared to the lowest quartile (Q1). Nevertheless, the top quartile (Q4) of breast milk pattern had a 3.26-fold greater risk of anemia than the lowest quartile (Q1) (OR = 3.26,95%CI:1.83 to5.81, P <0.001).

The constituent ratio among the four quartiles of dietary patterns in 2015 and 2018 was further show in Figure 1. The results displayed that significant differences of the constituent ratio among the four quartiles for four dietary patterns were found for 2015 vs 2018. Moreover, higher proportion of children in the top quartile (Q4) for traditional pattern, multi-nutrient powders pattern and breast milk pattern were found in 2015, while higher proportion of children in the top quartile (Q4) for diversified pattern was found in 2018.

Discussion

Our study identified four dietary patterns among infants aged 6 to 23 months in central-south China. Diversified pattern was mainly characterized by high consumption various foods. Traditional pattern was positively correlated with intake of cereals, water and soup, other vegetables and fruits, meat. Breast milk pattern was associated with high intakes of breast milk. Multi-nutrient powders pattern had high positive loadings for multi-nutrient powders. The prevalence of anemia among infant reduced from 29.49% in 2015 to 20.26% in 2018. The diversified pattern and multi-nutrient powders pattern deminished the risk of anemia, while breast milk pattern increased risk of anemia.

In the present study, the diversified pattern with a variety of food groups had high consumption of tubers, dairy products, bean and bean products, nut, dark leaf vegetables and fruits, meat and egg, and had higher rate of minimum dietary diversity and minimum acceptable diet assessing by World Health Organization infant and young child feeding indicators, corresponded to the guidelines or healthy pattern by previous studies[11, 19]. The traditional pattern was characterized by high intake of cereals, water and soup, other vegetables and fruits, meat, and multi-nutrient powders, similar to the traditional Chinese adults dietary patterns [20-22]. The breast milk pattern resembles the “breastfeeding” pattern reported by Lim [9] and Smithers [23], which was characterized by higher intake of breast milk and lower intake of formula milk. Lastly, the multi-nutrient powders pattern characterized by high intakes of multi-nutrient powders, sugar water and drink, powered formulas, has not been observed in other studies, and reflectes a special dietary pattern in central-south China, which may have association with multiple micronutrient supplementation in rural area of China. In China, multiple micronutrient supplementation called Ying Yang Bao (YYB), as a free program of government was developed in poor rural areas of China to improve children’s health since 2009 [24]. However, the multi-nutrient powders pattern had lower rate of minimum dietary diversity, minimum meal frequency and minimum acceptable diet. This result implies that the feeding practice of infants should be improved when the Yingyangbao program was implemented.

By the logistic regression model, the results revealed the diversified pattern deminished the risk of anemia, while breast milk pattern increased the risk of anemia. The diversified pattern was to offer infants a variety of food groups. Different studies shown that dietary diversity reduces the risk of malnutrition among infant and children[25, 26], and promotion of dietary diversity as a nutrition intervention has been used by many areas [27]. The breast milk pattern with higher intake of breast milk increased risk of anemia among infants. The breast milk was the best ideal food of infant but the concentration of iron is relatively low, which cannot meet the need of rapid growth and development of children after age 6 months [28]. Besides, we found that the multi-nutrient powders pattern decreased the risk of anemia. The multi-nutrient powders pattern had high intakes of multi-nutrient powders. The Yingyangbao program contained multi-nutrient powders had been proved to be an effective intervention in reducing anemia of children in rural areas of China [24, 29].

In addition, our study also show that children in 2015 had higher possibility of anemia than in 2018. On the one hand, the reason may partly attribute to the change of food habit from 2015 to 2018. We

found higher proportion of children adhered to breast milk pattern in 2015 and higher proportion of children adhered to diversified pattern in 2018. Diversified pattern reduced the risk of anemia while breast milk pattern increased the risk had been demonstrated by our multivariable logistic regression model. On the other hand, the decreasing prevalence of anemia from 2015 to 2018 may attribute to the higher proportion of children aged 18 to 23 months in 2018. Our previous study had demonstrated that the risk of anemia among childern 6 to 12 months of age was higher than that of children 18 to 23 months of age[14].

A strength of this study is that we collected data from two time period of cross-sectional surveys. It clarifies four patterns and its association with anemia among infants. Limitations of our study include that the recall error with regard to questionnaire information cannot be fully eliminated in Cross-Sectional designs. Furthermore, some foods were exclude, such as oil, salt and snacks, and food intake cannot be accurately assessed in our dietary survey. Lastly, all of the participants were from rural area, not represented the general population of children in China, which may limit the generalizability of our findings.

Conclusions

Four dietary patterns were identified among infants aged 6-23 months in central-south China. Diversified pattern and multi-nutrient powders pattern reduce the risk of anemia. However, the multi-nutrient powders pattern had lower rate of minimum dietary diversity, minimum meal frequency and minimum acceptable diet. Multiple micronutrient supplementation may be an effective measure to reduce risk of anemia among infants aged 6-23 months in central-south China, but feeding practice of infants should be improved and a variety of food groups should be strengthened.

Abbreviations

Hb: Hemoglobin;

n: Number;

OR: Odds Ratio;

CI:Confidence Interval;

YYB: Ying Yang Bao.

Declarations

Ethics approval and consent to participate

The written informed consent for participation in the study was obtained from their guardian before the interview. The project was approved by Huaihua Women's Federation and Municipal Commission of

Health and Family Planning.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

Self-funded

Authors' contributions

ZS conceived the research idea , analyzed data and revised the manuscript. ZA conceived the research idea and participated in data acquisition. LY revised the manuscript. HZ conceived the research idea, collected the data, performed the statistical analyses and drafted the manuscript. All authors approved the final version.

Acknowledgement

We thank the participants for their assistance and support.

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Figures

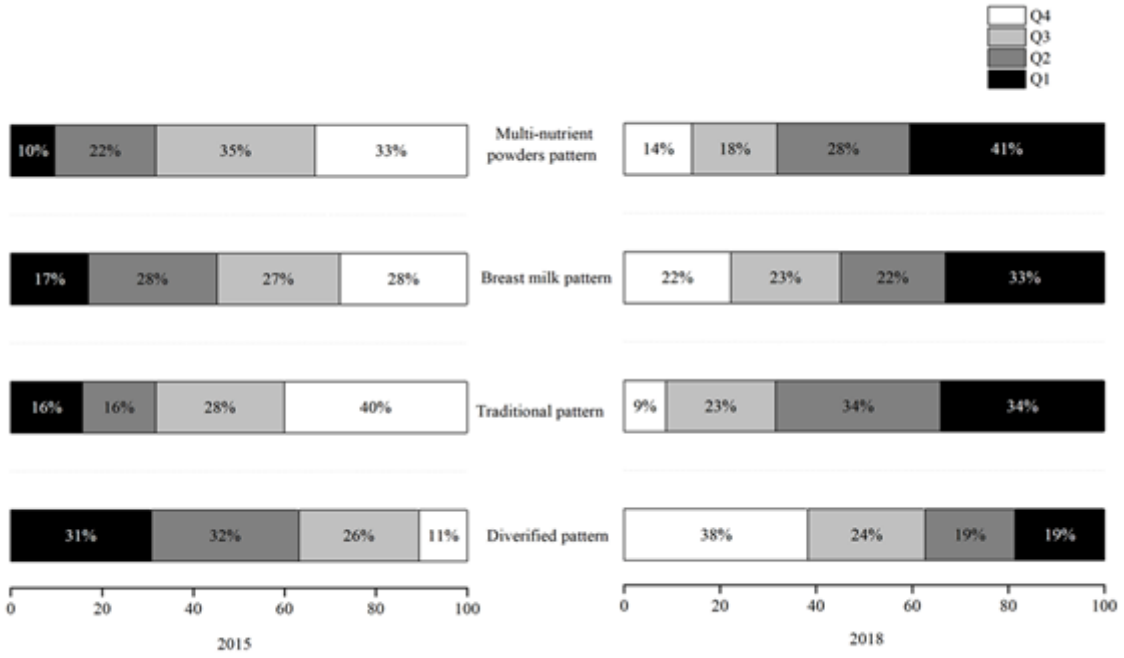

Figure 1

The constituent ratio among the four quartiles of dietary patterns, in 2015 and 2018. 2015 vs 2018, compared by χ2χ2=69.890, P<0.001, for divirified pattern; χ2=106.656, P<0.001, for traditional pattern; χ2=21.755, P<0.001, for divirified pattern; χ2=103.045, P<0.001, for multi-nutrient powders pattern;