Annals of Medicine and Surgery 81 (2022) 104317

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.elsevier.com/locate/amsu

Cross-sectional Study

Prevalence of malnutrition and associated factors among children aged 6–24 months under poverty alleviation policy in Shanxi province, China: A cross-sectional study

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ARTICLE INFO

Keywords:
Childhood malnutrition
Infant and young children
Risk factors
Supplementary food intervention
Policy

ABSTRACT

Introduction: Child malnutrition continues to be a major public health issue, accounting for 54% of all child mortality globally. This study aimed to determine the prevalence of childhood malnutrition and its associated risk factors as well as to explore the best developmental strategy among infants and young children (IYC).

Methodology: This cross-sectional study was conducted six months after the distribution of nutritious YingYangBao (YYB). It involved children aged 6–24 months in Shaanxi Province, China. Data were collected via interviews with parents of IYC, followed by measurements of the children's height and weight. Data were analyzed using EpiInfo software and SPSSv.26, which encompassed descriptive statistics, Pearson Chi-square, and multivariate logistic regression analysis. Ethics approval and parents' informed consent were attained prior to the study.

Result: A total of 3431 data were analyzed in the study. The prevalence of stunting was highest among IYC between 12 and 18 months (3.9%). Prevalence of underweight (0.5%) and wasting (1.5%) were highest among IYC aged 18–24 months while the prevalence of overweight was highest among IYC aged 6–12months (9.0%). Significant associating risk factors of malnutrition were IYC from Northern Shaanxi (aOR = 2.24; 95% CI:1.68–2.98) and mothers with parity ≥3 (aOR = 1.52; 95%CI:1.10–2.10). IYC with a higher educated father (aOR = 0.79; 95%CI:0.66–0.95), YYB intervention (aOR = 0.77; 95%CI:0.65–0.90), correct supplementary food time (aOR = 0.84; 95%CI:0.71–1.00) and separate supplementary food preparation (aOR = 0.79; 95% CI:0.66–0.95) were significantly associated with lower risk of malnutrition.

Conclusion: Even though the prevalence of stunting, underweight, and wasting were relatively low (<5%), there is still a need to strengthen existing policies on child nutrition.

1. Introduction

Even though malnutrition most often refers to undernutrition resulting from inadequate consumption, poor absorption, or excessive loss of nutrients, malnutrition also includes overnutrition. Underweight is a combined indicator of wasting and stunting, based on weight-for-age. It is recommended as a measure to monitor and evaluate the changes in the severity of malnutrition over time [1].

Childhood malnutrition continues to be the leading public health problem in developing countries. The effects of childhood malnutrition are long-lasting and persist to adulthood. For instance, malnutrition during early age decreases educational achievement, labor productivity, and raises the risk of chronic illnesses at later age [2]. The World Health Organization (WHO) estimates that malnutrition accounts for 54% of child mortality worldwide [3,4]. Childhood underweight accounts for 35% of all deaths worldwide for children under the age of five years [5–7]. Globally, around 1 to 2 million children die every year due to severe acute malnutrition and 20 million children live with severe acute malnutrition [8,9]. In fact, malnutrition is responsible for 60% of the 10.9 million deaths of children under 5 each year, either directly or

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https://doi.org/10.1016/j.amsu.2022.104317
Received 28 June 2022; Received in revised form 28 July 2022; Accepted 31 July 2022
Available online 10 August 2022

indirectly [8,9].

Severe acute malnutrition (SAM) affects around 2% of children in developing countries. Over the past fifteen years, the malnutrition trend in Ethiopia has shown a reduction in stunting by 31% and underweight by 39% [10,11]. However, there was only a small decline from 12% to 9% in the prevalence of wasting over the last 15 years [12].

SAM was responsible for 24.8% of the under-five malnourished children in Bahir Dar town [12]. The prevalence of underweight and wasting was 29% and 10%, respectively [12]. In low- and middle-income countries, the prevalence of underweight is 16% in urban areas and 30% in rural areas [13]. In Timor-Leste, more than 12 million children under the age of five had SAM at one time or the other [13]. Children under one year of age typically have a higher risk of SAM [14]. Malnutrition is influenced by various factors including insufficient food consumption, chronic infections, psychosocial deprivation, unsanitary environment, poor cleanliness, inequality, possibly some hereditary contribution, and low income [15,16].

According to a study in Uganda, malnutrition was noted to be independently associated with cognitive impairment, older age, and perinatal feeding issues [17]. Besides that, stunting among children in China was associated with numerous risk factors including preterm birth, low birth weight, history of respiratory illnesses and diarrhea, low parental education, poor socioeconomic status, and parental employment as migrant workers [18].

The nutrition improvement project for children was carried out by China National Health in poverty-stricken areas. This project utilized the central finance to provide free nutritious food YingYangBao (YYB) to infants between the ages of six and 24 months, in an effort to prevent infant malnutrition and anemia, as well as to improve the health of the children in impoverished areas. Moreover, overweight children were also included in the scope of this study. The aims of this study were to determine the prevalence of infant malnutrition and related risk factors in order to establish a foundation for the targeted application of recommendations on the effective use of feeding conditions, ongoing promotion of comprehensive interventions, as well as promotion of children's growth and development.

2. Materials and methods

2.1. Study setting

A cross-sectional study was conducted among children aged 6–24 months old in poverty-stricken areas in Shaanxi province in China, covering Southern Shaanxi, Northern Shaanxi, and Guan Zhong. The study was conducted in accordance with the declaration of Helsinki [The study was registered in the Research Registry with Unique Identifying number 7893, and the link is https://www.researchregistry.com/browse-the-registry#home/registrationdetails/6278a8d96a9c23001eed3b06/] and reported according to the STROCSS criteria [19]. Eleven districts (comprising 109 towns) were selected from four cities. The sample districts were selected according to 20% of 56 project districts in the province, including districts that were specifically monitored under China's poverty alleviation policy.

2.2. Study population

The study population encompasses IYC between 6 and 24 months old. The sample size was determined according to the "Working Manual for Monitoring and Evaluation of Children's Nutrition Improvement Projects in Poor Areas", which was a combination of stratified and multistage proportional sampling. 360 children were needed per district, and further divided into 120 children per subgroups of 6–12 months old, 12–18 months old, and 18–24 months old respectively. Hence, the total number of samples required was 3960.

2.3. Data collection

Six months after the distribution of Ying Yang Bao (YYB), the assessment as implemented from 2020.09 to 2020.10. Trained maternal and child health officers conducted one-to-one interviews with parents or guardians of IYC. This included in-depth details about the questionnaire which covered general information, dietary habits, nutritional knowledge, and parents' education level. Subsequently, measurement of the height and weight of the IYC were taken and recorded by the medical personnel in the questionnaire.

2.4. Statistical analysis

Statistical analysis was performed using EpiInfo software (version 3.1.1) and SPSS version 26.0. A description of the sampled participants was analyzed using univariate analysis and reported in terms of frequency and percentages. Pearson's Chi-square test was performed to assess the association between categorical independent and dependent variables. The multiple logistic regression was used to generate the best-fitting and reasonable model, defining the association of the independent variables with the dependent variable (malnutrition status of children), and exploring the additional factors that influenced malnutrition. A p-value of <0.05 was considered statistically significant. The comprehensive model coefficient test results and Hosmer-Lemeshow (H&L) test showed that this regression model was meaningful, indicating a high degree of goodness of fit model.

2.5. Malnutrition indices

The dependent variable for this study was the malnutrition status of under 5-year-old children and was defined according to World Health Organization (WHO). Children whose height-for-age Z-score is below two standard deviations (−2 SD) from the median of the reference population are considered to be stunted. If the weight-for-age Z-score is below two standard deviations (−2 SD) from the median of the reference population then the child is underweight. Children whose weight for height Z-score is below two standard deviations (−2 SD) from the median of the reference population are considered as wasted (Tekile et al., 2019).

Ethical approval

Ethical approval for the study was obtained from National Institute for Nutrition and Health and the Chinese Center for Disease Control and Prevention, and from Health Center Science of Xi'an Jiao tong University (Number: 2020–1251). Approval was obtained from the Health Science Center of Xi'an Jiaotong University prior to the commencement of the study. Informed written consent was obtained from the IYC's parents or guardians prior to their participation. The informed consent stated the purpose of the study, study confidentiality, and the voluntary right of participation in the study, as well as provided the assurance that no participant would suffer any harm as a result of his/her participation in the study.

3. Results

A total of 3960 questionnaires were collected throughout the study but only 3431 data were analyzed. In this study, 494 (29.3%) boys and 532 (30.5%) girls suffered from malnutrition. The stunting rate of IYC in Northern Shaanxi was 4.6%, followed by 3.1% in Southern Shaanxi and 1.0% in Guan Zhong. However, the proportion of overweight was more than 14% in Northern Shaanxi. In Guan Zhong area, the prevalence of underweight was less than 1% while the prevalence of overweight was 6.6%. The prevalence of underweight among IYC in the three regions accounted for less than 0.5% while prevalence for wasting was between 1% and 2%. Prevalence of stunting in IYC aged 12-18 month-age age

Table 1
Prevalence of malnutrition among IYC in different regions and different age groups.

Regions	Stunting	Not stunting	Under weight	Not under weight	Wasting	Not wasting	Over weight	Not over weight
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
According to location								
Northern Shaanxi	26 (4.6)	542 (95.4)	2 (0.4)	566 (99.7)	7 (1.2)	561 (98.8)	82 (14.4)	486 (85.6)
Southern Shaanxi	70 (3.1)	2169 (96.9)	11 (0.5)	2228 (99.5	27 (1.2)	2212 (98.8)	168 (7.5)	2071 (92.5)
Guan Zhong	6 (1.0)	618 (99.0)	2 (0.3)	622 (99.7)	12 (1.9)	612 (98.1)	41 (6.6)	583 (93.4)
According to age Group								
6–12m	22 (1.9)	1117 (98.1)	5 (0.4)	1134 (99.6)	102 (9.0)	1037 (91.0)	15 (1.3)	1037 (91.0)
12–18m	44 (3.9)	1081 (96.1)	4 (0.4)	1121 (99.6)	98 (8.7)	1027 (91.3)	13 (1.2)	1112 (98.8)
18–24m	36 (3.1)	1131 (96.9)	6 (0.5)	1161 (99.5)	91 (8.1)	1027 (91.9)	18 (1.5)	1149 (98.5)

Table 2
Differences in overweight and stunting among IYC in different regions and different age groups.

	Overweight	Not overweight	x^2	*P*
	N (%)	N (%)		
Northern Shaanxi	82 (14.4)	486 (85.6)	31.646	0.000
Southern Shaanxi	168 (7.5)	2071 (92.5)		
Guan Zhong	41 (6.6)	583 (93.4)		
6–12 months	15 (1.3)	1037 (91.0)	1.109	0.574
12–18 months	13 (1.2)	1112 (98.8)		
18–24 months	18 (1.5)	1149 (98.5)		
	Stunting N (%)	**Not stunting N (%)**	x^2	*P*
Northern Shaanxi	26 (4.6)	542 (95.4)	14.004	0.001
Southern Shaanxi	70 (3.1)	2169 (96.9)		
Guan Zhong	6 (1.0)	618 (99.0)		
6–12 months	22 (2.0)	1117 (98.1)	7.766	0.021
12–18 months	44 (3.9)	1081 (96.1)		
18–24 months	36 (3.1)	1131 (96.9)		

group was higher than other two groups. Prevalence of malnutrition according to regions and age groups are summarized in Tables 1 and 2.

3.1. Univariate analyses

As the age increases, the percentage of malnutrition decreases. The prevalence of malnutrition among those aged 6–12months was higher than the other age groups ($p = 0.001$). Similarly, malnutrition was prevalent among children from Northern Shaanxi ($p < 0.01$). The prevalence of malnutrition among IYC who were delivered via cesarean delivery was lower compared with IYC with vaginal delivery. Children who had history of premature birth were associated with malnutrition ($p < 0.05$). Children who were breastfed were less likely to have malnutrition, but no statistical difference noted ($p > 0.05$). As parity increases, proportion of malnutrition increases with statistical significance ($p < 0.01$). In addition, higher education level of children's parents, higher family income and caregivers having more health education knowledge were associated with lower prevalence of children malnutrition ($p < 0.01$). IYC who took YYB and other nutrients were noted to have lower prevalence of malnutrition ($p < 0.05$). Univariate analysis are tabulated in Table 3.

3.2. Multivariate model

In order to estimate the relative contribution of each indicator variable related to malnutrition, Multivariate Logistic Regression Analysis was conducted. Compared to IYC in different regions, children in Northern Shaanxi were 2.2 times more likely to have malnutrition (aOR = 2.24; 95% CI: 1.68–2.98). In addition, children of father with higher education level (aOR = 0.79; 95% CI: 0.66–0.95) and mother with permanent jobs (aOR = 0.64; 95% CI: 0.50–0.83) were less likely to have malnutrition. IYC with mothers of parity 3 or more had a 1.5 higher odds of malnutrition (aOR = 1.52; 95% CI:1.10–2.10) compared with those with mothers with parity less than 2.

On the other hand, supplementary food also affected the prevalence of malnutrition. IYC who took YYB, iron supplementation or other nutrients (aOR = 0.77; 95% CI:0.65–0.90), correct supplementary food time (aOR = 0.84; 95%CI:0.71–1.00) and separate supplementary food preparation (aOR = 0.79; 95%CI:0.66–0.95) were significantly associated with lower risk of malnutrition. Table 4 illustrates the multivariate logistic regression analysis of influencing factors of malnutrition.

4. Discussion

In developing countries, malnutrition among children is a major public health concern. It has an impact on all aspects of a child's life, including their emotional, social and spiritual welfare in addition to their physical health [2]. Malnutrition increases the risk of adverse social, cognitive, and health outcomes, including the risk of mortality. Addressing food insecurity remains a challenge in many developing countries, leaving children with disabilities particularly vulnerable to malnutrition and its associated consequences [12].

According to the study's findings, the prevalence of stunting in Northern Shaanxi decrease by 38.7%, from 7.5% in the same region in 2015 to 4.6% following YYB intervention in 2021. In addition, prevalence of stunting in Southern Shaanxi declined by 45.9%, from 5.8% in 2015 to 3.1% in 2021. However, the proportion of overweight increased by 20%. The prevalence of underweight and wasting noted a drastic decrease compared to 2015, from 10.7% to 1.3% and 4.9%–0.4% respectively in this study [18]. The differences of stunting for IYC between regions are statistically significant. It is considerably less than the prevalence of stunting, underweight, wasting in Iranian provinces in 2014, which were 12.4%, 10.5% and 7.8%, respectively [20]. SAM was affected by regional and national variances in about 18.1% and 35.9% of cases, respectively [21]. The prevalence of stunting was common in the Middle East and North Africa at 32% and in South Asia at 48% [22]. Additionally, a study found that 40% of children who suffered from stunting were under 42 months old [23].

Results of a study conducted in Indonesia on children under five showed that 38.4% and 18.4% of children suffered from stunting and severe stunting, respectively. The overall prevalence of malnutrion in this study was lower than global statistics. The prevalence of wasting, stunting and underweight in the world were 8, 25 and 15%, respectively on UNICEF's annual report in 2014 [24]. The odds of an under 5 child developing SAM may increase by about 157% and 122% after moving to another neighborhood or another country [14]. This explained that severe malnutrition may be closely related to the area where infants and young children were located, which is similar to the results of this study.

The findings of this study provided evidence that malnourished IYC in the sampled population in Shaanxi province in China, were lower than five years ago. This was due to several interventions taken by the Chinese government and various development organizations. This study highlights the areas for future improvement of the nutritional status of 6-to-24 month-age children in China. This is closely related to the poverty alleviation policies of the Chinese government in the recent years. Under

Table 3
Univariate analysis of malnutrition.

Influencing factors	Not Malnutrition		Malnutrition			
	n	%	n	%	χ^2	p
Gender						
Male	1191	70.7	494	29.3	0.543	0.461
Female	1214	69.5	532	30.5		
Birth weight						
Underweight	78	65.0	42	35.0	1.790	0.409
Normal	2187	70.4	938	30.0		
Overweight	110	68.8	76	40.9		
Delivery method						
Natural delivery	1355	69.8	574	29.8	0.036	0.850
Caesarean section	1060	70.1	442	29.4		
Is it premature?						
Yes	97	61.6	48	33.3	4.145	0.042*
No	2326	70.1	960	29.2		
Month-age groups						
6-12	758	66.5	381	33.5%	14.795	0.001*
12-18	785	69.8	340	30.2%		
18-24	862	73.9	305	26.1%		
Parity						
1	1075	73.2	415	27.8%	23.623	<0.001*
2	1151	69.6	523	31.2%		
≥3	147	56.8	120	44.9%		
Region						
Guan Zhong	478	76.6	146	23.4%	63.994	<0.001*
Northern Shaanxi	322	56.7	246	43.3%		
Southern Shaanxi	1605	71.7	634	28.3%		
Mother's education						
Primary and below	192	62.7	114	37.3%	21.173	<0.001*
Junior	1173	68.2	547	31.8%		
High level and above	1040	74.0	365	26.0%		
Mother profession						
Housework	1090	65.4	576	34.6%	36.880	<0.001*
Permanent job	449	77.3	132	22.7%		
Farmer/Migrant workers/Others	866	73.1	318	26.9%		
Father's education						
Primary and below	168	62.9	99	37.1	24.707	<0.001*
Junior	1158	67.6	556	32.4		
High level and above	1079	74.4	371	25.6		
Father profession						
Housework	117	66.5	59	33.5	3.557	0.169
Permanent job	769	72.1	298	27.9		
Farmer/Migrant workers/Others	1519	69.4	669	30.6		
Caregivers						
Parents	1763	68.8	801	31.2	11.527	0.003*
Grandparents	595	74.8	200	25.2		
Others	47	65.3	25	34.7		
Caregiver's education						
Primary and below	452	67.7	216	32.3	9.425	0.009*
Junior	1184	68.9	535	31.1		
High level and above	769	73.7	275	26.3		
Caregiver profession						
Housework	1387	67.2	678	32.8	24.105	<0.001*
Permanent job	262	78.2	73	21.8		
Famer/Migrant workers/Others	756	73.3	275	26.7		
Family income						
≤30 k	763	67.1	403	34.7	6.011	0.049*
30 k~50 k	838	70.8	363	30.2		
> 50 k	764	71.7	300	28.2		
Is supplementary food made separately?						
No	690	67.4	333	32.6	4.874	0.027*
Yes	1715	71.2	693	28.8		
Whether breastfeeding after birth						
No	251	66.1	129	33.9	3.333	0.068
Yes	2154	70.6	897	29.4		
Whether to take YYB						
Yes	945	67.7	451	32.3	6.483	0.011*
No	1460	71.7	575	28.3		
The right time to add complementary food						
Wrong	842	67.4	407	32.6	6.741	0.009*
Correct	1563	71.6	619	28.4		
Which nutrients are lacking on anaemia						
Wrong	725	67.5	349	32.5	5.009	0.025*

*Statistically significant if p-value < 0.05.

Table 4
Multivariate logistic regression analysis of influencing factors of malnutrition.

Variable	B	S.E.	Waldχ^2	*P*	Adjusted OR (95%CI)
Month-age groups					
6-12			8.668	0.013	
12-18	−0.101	0.099	1.033	0.310	0.904 (0.744,1.098)
18-24	−0.293	0.101	8.475	0.004	0.746 (0.613,0.909)
Parity					
1			6.305	0.043	
2	0.089	0.087	1.050	0.305	1.093 (0.922,1.295)
≥3	0.421	0.169	6.222	0.013*	1.524 (1.095,2.123)
Region					
Guan Zhong			41.758	<0.001	
Northern Shaanxi	0.804	0.146	30.351	<0.001*	2.235 (1.679,2.975)
Southern Shaanxi	0.135	0.118	1.317	0.251	1.145 (0.909,1.443)
Mother's profession					
Housework			14.852	0.001	
Permanent job	−0.440	0.128	11.799	0.001*	0.644 (0.501,0.828)
Famer/Migrant workers/Others	−0.248	0.095	6.822	0.009	0.780 (0.647,0.940)
Father's education					
Primary and below			6.380	0.041	
Junior	−0.079	0.150	0.278	0.598	0.924 (0.689,1.239)
High level and above	−0.239	0.094	6.553	0.010*	0.787 (0.655,0.945)
Make supplementary food separately	−0.239	0.094	6.553	0.010*	0.787 (0.655,0.945)
Whether to take YYB	−0.263	0.083	10.075	0.002*	0.769 (0.653,0.904)
Correct supplement food time	−0.173	0.085	4.099	0.043*	0.841 (0.712,0.995)

B = beta coefficient, S. E. = standard error, OR = odds ratio, CI = confidence interval.
* Statistically significant if p-value <0.05.

the promotion of the whole society's health industry, the health of infants and young children has been highly valued by the government, and the nutrition package intervention project in poverty-stricken areas has been successfully carried out.

From the results, this intervention was noted to be effective and promote the overall health of local infants and young children, exceeding our expected target. The current problem is that the overweight rate of infants and young children has also increased. Given that there is a statistically significant difference between northern Shaanxi and southern Shaanxi, analysis of the reasons may be related to better living conditions or local living habits. Further analysis on the dietary structure of local IYC as well as contributing factors of overweight are crucial to provide an objective theoretical basis for further intervention measures.

The prevalence of malnutrition is also statistically significant

according to age group ($p < 0.05$). Infants aged 6–12 months had a lower prevalence of stunting than infants aged 12–18 months. The prevalence of stunting among the 18–24 months IYC was in between the other two groups, while the prevalence of underweight was higher among the 18–24 months. Nevertheless, these findings were lower than five years ago, and the trend of change was consistent with the results of previous studies [13.26]. The possible reasons were related to the intervention measures in recent years, which include weaning time, type, and quality of supplementary food being added in the diet of IYC. It is vital to further explore the dietary combination of IYC, particularly on supplementary food addition to determine the reasons of changes in various age groups.

Previous study indicated that the risk factors of severe acute malnutrition were large family size, low income, higher number of siblings as well as living conditions like types of house, open air defecation and inappropriate IYC feeding practices [25]. Other factors associated with child malnutrition include parents' education level, wealth index, mother's BMI, division, antenatal care service during pregnancy, birth interval of children and low birth weight [26]. After the age of six months, underweight and wasting in the children might be caused by improper supplemental feeding and food use techniques [27]. In addition, toxicant exposures may worsen the micronutrient status, especially during the womb-to-childhood development, and increase the risk of health disorders in adulthood [28].

Multivariate Logistic Regression analysis revealed that preparing supplementary food separately was associated with decreased odds of malnutrition (OR = 0.79; 95% CI:0.66–0.95). Parents with lower education degree can be considered as contributing factors to the prevalence of malnutrition, which is consistent with previous study [29]. IYC in Northern Shaanxi were more likely to be malnourished, which is attributed to poor geographical environment, significant temperature difference, increased wind intensity and less vegetation. On the other hand, despite having relatively good climate conditions, with mountains and water, suitable temperature and humidity, Southern Shaanxi's economy is underdeveloped and there is limited access to information. Guan Zhong has good economic conditions but more serious pollution. Therefore, malnutrition has a certain association with geographical environment, economic conditions and air pollution factors. Additionally, it is important to focus on improving the environment by planting more trees, raising awareness of nutrition and hygiene among parents, and taking action to lessen environmental pollution along with nutritional supplement therapies.

Pro-urban inequalities were mostly affected by neighborhood socioeconomic status and wealth index which were related to SAM among under-five children [13]. The univariable analysis and multivariate model used in the study were based on the identified factors associated with malnutrition. Among the risk factors for malnutrition, the parents' occupation, educational background and family income were consistent with previous studies [12.13]. According to the analysis of this study, parents who were more educated and affluent, were in a better position to have access to knowledge and information that could improve their decision making in providing adequate and sufficient nutritious foods to their children.

Besides, the higher propensity of the better-off parents to use health care services and more knowledge from internet could reduce the risk of malnutrition among their children. From this study, additional risk factors which included month-age, regions, parity, whether to make supplementary food separately, whether to take YYB and other nutrients, whether to add complementary food for IYC at the right time, were closely related to malnutrition. Therefore, caregivers should be encouraged to prepare separate foods for IYC in accordance with the requirements of nutritious diet and the physiological needs of IYC of different month-age groups. Food additives and junk food that not only have contribute to weight gain but also no nutritional value should be avoided. To achieve this goal, guardians and parents need to receive adequate nutritional and health education lectures, either via face-to-face or online training. In the meantime, further analysis on the dietary structure of IYC is necessary to determine the root cause of the problem so that implementation of targeted and comprehensive intervention measures can be carried out to prevent or minimize the occurrence of malnutrition in IYC.

Among the limitations noted was no baseline data were collected prior to the YYB intervention due to the impact of corona virus pandemic. Hence, no direct comparison for pre-and post intervention was available. Data were only compared from older statistics in 2015. Besides that, many forms with missing data were discarded.

5. Conclusion

The prevalence of stunting, underweight and wasting was reduced greatly under China's poverty alleviation policy and the implementation of the nutrition project intervention. Unfortunately, prevalence of overweight among IYC is on the rise. There is a necessity to strengthen as well as advocating existing child nutrition policies and to re-inforce public health prevention strategies targeted at children in poverty areas. Besides that, it is crucial to analyze IYC's dietary structure to explore the contributing factors identified in the present study which may assist in explaining the disparities in malnutrition and potential risk factors among 6-24 month-age children residing in high-risk places. In the future, follow-up surveys on IYC need to be conducted particularly those who underwent nutritional intervention. This approach is vital to evaluate the effectiveness of the program as well as to provide source of references for the implementation of projects in other provinces, and to strive to achieve the ultimate goal of improving the malnutrition of children in poverty-stricken areas of China.

Ethical approval

Ethical approval for the study was obtained from National Institute for Nutrition and Health and the Chinese Center for Disease Control and Prevention, and from Health Center Science of Xi'an Jiao tong University (Number: 2020–1251).

Sources of funding

The study was supported by UMSGreat Grant (Approval code: GUG0514-2/2020), a Postgraduate Research Grants from the University of Malaysia Sabah (UMS). The study sponsor was not involved in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication.

Author contribution

Minli Zhang was involved in the study design, carried out the data collection, conducted the statistical analysis and interpretation as well as drafted the manuscript. Nelbon Giloi supervised the study design, reviewed the analysis, and facilitated the manuscript writing Yang Shen, Yan Yu, and Aza Sherin M.Y were involved in designing the concept of the study. Mei Ching Lim facilitated in writing the manuscript. All authors agreed and approved the final version for publication.

Registration of research studies

Name of the registry: *Research Registry*.

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Consent

Informed written consent was obtained from the parents or guardians of the participants prior to their participation. The informed consent stated the purpose of the study, study confidentiality, and the voluntary right of participation in the study, as well as provided the assurance that no participant suffered any harm as a result of his/her participation in the study.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Declaration of competing interest

The authors have no conflict of interest do disclose.

Acknowledgement

We are thankful to the university for awarding us the research grant, which was a great financial support for the study. We are appreciative to all the parents who agreed to participate and giving us their utmost cooperation throughout this research.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.104317.

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