Analysis of the growth and development status of malnutrition and anemia in 352 children aged 0-3 years in Minhang community of Shanghai and evaluation of the effect after intervention

Xiaoxi Xu[1]*, Yubo Tian[1], Yamin Chu[1] and Bing Li[2]
[1]Department of Children's Health Management Center, Gumei Community Health Service Center, Minhang District, Shanghai, China
[2]Department of Public Health Division, Gumei Community Health Service Center, Minhang District, Shanghai, China

Abstract: The growth status of 352 malnourished and anemic children aged 0-3 years in Minhang District, Shanghai, were analyzed, and the effectiveness of health interventions was evaluated. The work focused on 352 malnourished and anemic children aged 0-3 years, summarized their health status by conducting two questionnaire surveys, and evaluated the effects of health interventions. The results revealed that the proportion of malnourished and anemic boys (57.10%) was slightly higher than that of girls (42.90%); and malnutrition-induced anemia accounted for 32.95% of the total number of children. The initial symptoms of malnourished children mainly manifested as below-normal height, weight loss, intellectual developmental delay and decreased muscle tone. Factors such as birth weight, number of infants, mode of delivery, preterm birth, feeding method, complementary feeding, medical history, and educational level of parents and primary caregivers had certain impacts on growth of children. Furthermore, the level of awareness of nutritional disorders knowledge was higher after the intervention compared to before the intervention. In conclusion, health education interventions for malnourished children can effectively improve their condition and enhance their overall health status, warranting widespread application and promotion.

Keywords: Infants, malnutrition, anemia, health education intervention.

INTRODUCTION

In the growing process of children, various reasons may cause the lack of protein or energy in the body, thus destroying the normal metabolic stability of children and causing the self-consumption of body tissues (Kulkarni, 2021; Caicedo-Gallardo, 2021).When malnutrition occurs in children, various organ dysfunction and other nutrient deficiency often occur in succession (Djuardi, 2021). There are many reasons for malnutrition in children, the most common of which are high metabolic status caused by insufficient nutritional intake, restricted eating, trauma, surgery or infection, and chronic wasting diseases such as tumors or long-term diarrhea (Rivadeneira, 2020; Rahman, 2019). The symptoms of children suffering from malnutrition are mainly concentrated in weight loss, subcutaneous fat loss, edema, anemia, and other aspects (Clark, 2018; Mrimi, 2022). Some children will have clinical manifestations such as feeling of weakness, hypoglycemia, dry skin, hair loss, and large liver (Jesus, 2018). Regardless of the cause of malnutrition, if the body condition is not improved for a long time, it should be diagnosed in time, and the physician should evaluate the nutritional status of the child according to the situation and give the best treatment measures. Clinically, there are two common treatment measures for child malnutrition. The first is to provide personalized nutritional support for children, and the second is to provide treatment for the primary disease (El-Shafie, 2020; Zhang, 2020).

Pediatric anemia is a decrease in the number of red blood cells or hemoglobin content per unit volume caused by some reason in the peripheral blood of the body, which is relatively common in clinic (Leidman, 2018; Lewis, 2020). Due to the rapid development of the body, children often have a high demand for various nutritional elements, so a variety of external stimuli can lead to anemia in children, such as malnutrition and various chronic diseases (Din, 2018). Relevant studies have confirmed that the younger children are, the more likely they are to develop anemia (Varghese, 2019). The prevalence rate of children under 5 years old is about 47%, and that of school-age children is about 25% (Peña-Rosas, 2019; Pandit, 2021). Children with anemia, according to the different causes of the disease, the clinical manifestations are also different. Generally, speaking, when children develop acute anemia, the degree of anemia in this case is usually not too serious, but it may also cause adverse effects on the children's body, and even lead to shock when the degree is deeper (Chiang, 2021; Al-Jawaldeh, 2021). If the child is chronic blood loss, the replacement of hematopoietic function of various organs in the early stage of the disease is better, so the child will almost not have too obvious symptoms. When the replacement hematopoietic function is disabled, the children will usually gradually show corresponding symptoms, and the normal intellectual development and immune function of the children will be affected (Chiang, 2020; Curi-Quinto, 2020). The most common clinical manifestationsof children with anemia are that their skin and mucosa are paler than those of healthy children. If the children have anemia for a long time, they will also be

Corresponding author: e-mail: duduangu0707596581@163.com

prone to fatigue, dry and withered hair, and physical growth retardation (Chiang, 2020). Anemia in infancy usually causes enlargement of the liver, spleen, and lymph nodes. Therefore, no matter what the cause of anemia is, it will bring adverse effects on the normal growth and development of children, and should be treated by doctors in time (Schechter, 2019; Wu, 2020).

The nutrition and health status of children can reflect the nutrition status and social development level of our country to a certain extent (Sumbele, 2021). In recent years, with the rapid development of the overall economic level of the society and the steady improvement of people's living standards, the incidence of malnutrition in children has been significantly reduced (Małyszko, 2021). However, it has not yet reached the ideal state, especially malnutrition in school-age children is still relatively common, and the detection rate of child malnutrition in different regions is not consistent (Huang, 2021; Islam, 2021). In order to regulate the nutritional status of children more effectively in this area, 352 children aged 0-3 years old in Minhang Community of Shanghai were selected for investigation. The growth and development status of children with malnutrition and anemia were analyzed in detail and the effects of intervention were scientifically evaluated, in order to provide reference for relevant departments to formulate relevant nutrition intervention measures and actively and effectively improve the nutritional status of children.

MATERIALS AND METHODS

General data
A total of 352 children aged between 0 and 3 in Minhang community in Shanghai between July 2019 and April 2020 were selected as the research objects, including 201 boys and 151 girls. Their average age was 9.9±5.4 months and average weight amounted to 2368±117g. The initial symptoms among 352 children with malnutrition mainly included height less than normal level, weight loss, intellectual retardation, and muscle tension retardation. Besides, the nutritional knowledge and behaviors of children's parents were investigated. After the first questionnaire, health education intervention was carried out. After 9 months, the second questionnaire was implemented. After that, the results of the two questionnaires were compared to analyze health intervention effects. The implementation of this research had been approved by Gumei Community Health Service Center Ethics Committee and children as well as their family members had been informed of the research contents and methods. In addition, they had agreed to sign corresponding informed consent forms.

The inclusion criteria were as follows:
A. Children aged between 0 and 3 with malnutrition
B. Children with complete basic data
C. Children willing to cooperate with the investigation

The exclusion criteria were as follows.
A. Children with severe infectious diseases
B. Children with incomplete basic data
C. Children with serious mental diseases

Methods
Questionnaire
Through literature review and relevant questionnaire design, the questionnaire of this project was developed. After the preliminary investigation, relevant experts were organized to discuss the questionnaire and further improve the content of the questionnaire. In order to ensure the consistency of the questionnaire survey process, uniform survey training and evaluation were conducted before the formal survey. Face-to-face survey was conducted by uniformly trained investigators, who filled in questionnaires. The questions and answers involved in the questionnaire were determined through expert discussion. The contents include children's basic information (main feeders, gender, age, birth mode and disease history after birth, etc.), children's feeding status (feeding method within 6 months, whether breast-feeding, milk substitute addition, types of complementary food, etc.), family economic status (Education level of parents, education level of main feeders, occupation of parents, per capita monthly income of family, etc.) (Jesson, 2018;Gong, 2022). The investigators are specially trained community health and epidemic prevention station personnel. The questionnaire is filled out by the parents of the children, and the individual parents with low education level are asked by the investigators and then filled in on behalf of them.

Health education intervention
Scientific increase of dietary supplement
According to the specific manifestations of different patients, dietary supplement was added using scientific methods to meet patients' needs for nutrients. Dietary supplement for different children should be gradually increased from a small amount to ensure that they could fully adapt to the change in the additive amount.

Comprehensive promotion of knowledge about children nutrition
Knowledge about children nutrition should be posted comprehensively on community bulletin boards. The lecture on nutritional knowledge needed to be organized and implemented regularly. The wrong feeding methods adopted by parents should be managed in time to ensure the comprehensive guidance on parents' feeding of their children.

Adjustment of feeding methods
Reasonable feeding management was performed on different children. Children with loss of appetite should be guided step by step. It must be ensured that parents mastered various feeding techniques and children feeding methods reasonably to improve infants' physical

immunity. In addition, the clinical nursing effects on children and family members' satisfaction of nursing before and after intervention were compared and analyzed to obtain corresponding research results.

Follow-up revisit

Children underwent return visit interventional treatment, which required their parents' active cooperation. Besides, follow-up plan was formulated, the purpose of return visit was clarified, the time of return visit was selected and the communication process was designed. Parents were told to get prepared mentally. Physicians needed to effectively communicate with children's family members and put forward their own proposals in appropriate time to seek approval for the consolidation of treatment outcomes. Children with malnutrition were followed-up to extend intervention pattern design, as shown in fig. 1 below.

Observation indexes

The current malnutrition, anemia, growth, development of 352 children aged between 0 and 3 in Minhang community in Shanghai were analyzed (the main causes included picky eating, unreasonable nutrition arrangement, poverty, premature infants, and parents' educational levels).

The clinical effects on children before and after health education intervention were analyzed. The specific reference criteria were displayed in tables 1 and 2 below.

Ethical approval

The study was carried out in compliance with guidelines issued by Ethical Review Board and Institutional Biosafety Committee of Gumei Community Health Service Center, Minhang District.

STATISTICAL ANALYSIS

The research data were processed and analyzed by SPSS24.0 statistical software. Measurement data were expressed as mean±standard deviation (X±S). Enumeration data were denoted by percentage. Pairwise comparison was performed by variance analysis. $P<0.05$ indicated that the difference was statistically significant.

RESULTS

General data on children

The statistical results of basic information for 352 malnourished and anemic children are summarized in Table 3. Among all malnourished children, boys and girls accounted for 57.10% and 42.90% respectively. It is evident that the proportion of malnourished and anemic boys is slightly higher than that of girls. The average age was (9.9±5.4) months, and the average weight was (2368±117) g. The initial diagnosis revealed that 186 children were classified as mildly malnourished, accounting for 52.85%. Additionally, 116 children were diagnosed with anemia, representing 32.95%. Additionally,

a total of 50 children were diagnosed with severe malnutrition, accounting for 14.20%.

Incidence of malnutrition

As displayed in fig. 2 below, 70 children with malnutrition were 1 to 2 months old, 23 were 3 to 4 months old, 110 were 5 to 8 months old, 70 were 9 to 12 months old, 25 were 13 to 18 months old, 28 were 19 to 24 months old, and 26 were 25 to 31 months old. The initial symptoms among 352 children with malnutrition mainly included height less than normal level, weight loss, intellectual retardation, and muscle tension retardation. A total of 34 children suffered from muscle tension retardation, 60 suffered from height less than normal level, 230 suffered from weight loss, and 28 suffered from intellectual retardation, as illustrated in fig. 2 below.

Analysis of causes of the incidence of malnutrition

The results of the questionnaire survey are presented in Table 4. It clearly indicates that factors such as birth weight, number of babies, mode of delivery, preterm birth, feeding method, complementary feeding, the medical history of children, educational levels of both parents, and the educational level of the primary caregiver have certain impacts on the growth and development of toddlers. Among them, the highest proportion of malnourished children based on birth weight is observed in those weighing equal to or greater than 2,500g, with 344 cases accounting for 97.73%. The highest proportion of single-birth infants is observed in the category of babies with 237 cases, accounting for 67.33%. Regarding the mode of delivery, the highest proportion is found in naturally delivered infants, with 168 cases representing 47.73%. The majority of children, 342 cases or 97.16%, are not born prematurely. Among the feeding methods, the highest number of cases, 195 in total, accounting for 55.40%, were breastfed. In terms of complementary feeding, the majority of cases, 297 in total, accounting for 84.38%, exhibited inappropriate practices. Among all malnourished children, the highest proportion, 61.08%, corresponds to those without any medical history. Concerning the educational level of fathers, the highest number of cases, 294 in total, accounting for 83.52%, had at least a college degree. Similarly, among mothers, the highest number of cases, 296 in total, representing 84.09%, had at least a college degree. The primary caregiver, in the majority of cases (246 cases or 69.89%), had an educational level of at least a college degree. Moreover, 180 cases, accounting for 51.14%, had no complications during pregnancy or lactation for the mother.

Intervention results

The number of cases falling into the score ranges of 0-59, 60-79, and 80-100 for the first assessment of nutritional disorder knowledge were 124, 148, and 80 respectively. For the second assessment, the corresponding numbers of cases were 20, 154, and 178. The differences between the two assessments were statistically significant ($P< 0.05$), as

Table 1: Assessment criteria for disease outcomes and effective management

Items	Reference criteria
Disease outcomes (NA)	The results of final return visit (0=closure, 1=improvement, 3=serve to mild, 4=hemoglobin increased by or over 5g, 5=ineffective, 6=referral, 7=mild to serve, 8=no return visit, and 9=hemoglobin increased less than 5g)
Effective management (NC)	0=improvement in at least one return visit, 1=closure, 3=referral completion, 4=hemoglobin increased by or over 5g, 5=all return visit results were ineffective, 6=no return visit, and 7=only one return visit and hemoglobin increased less than 5g

Table 2: Assessment criteria for the understanding level of knowledge about nutritional diseases, disease improvement, effective management, standard follow-up, and the increase in the understanding rate of nutritional disease knowledge

| Items	Reference criteria
First understanding of nutritional disease knowledge	0=didn't understood too much (0-59),1=understood some (60-79), 2=understood (80-100)
Second understanding of nutritional disease knowledge	0=didn't understood too much (0-59),1=understood some (60-79), 2=understood (80-100)
Disease improvement	1=yes: NA0-5, 0=no: NA6-9
Effective management	1=yes: NC0-4, 0=no: NC5-6
Standard follow-up	1=yes, 0=no
Increase in the understanding rate of nutritional disease knowledge	1=yes, 0=no

Table 3: General data on children

Items	Types	Proportion of patients n (%)
Gender	Male	201 (57.10%)
	Female	151 (42.90%)
Age	Average age (months)	9.9±5.4
Weight	Average weight (g)	2368±117
The first diagnosis	Mild malnutrition	186 (52.85%)
	Anemia	116 (32.95%)
	Severe malnutrition	50 (14.20%)

Table 4: Investigation results of factors related to malnutrition among infants aged between 0 and 3

| Factors	Types	Number of infants	Percentage
Birth weight	<2500g	8	2.27%
	≥2500g	344	97.73%
Number of infants	Single infant	237	67.33%
	Twins	115	32.67%
Birth ways	Natural delivery	168	47.73%
	Assisted delivery	55	15.63%
	Cesarean section	129	36.65%
Whether premature delivery occurred	Yes	10	2.84%
	No	342	97.16%
Feeding methods	Brest-feeding	195	55.40%
	Mixed feeding	110	31.25%
	Artificial feeding	47	13.35%
Dietary supplement	Reasonable	55	15.63%
	Unreasonable	297	84.38%
Previous history of diseases	Yes	137	38.92%
	No	215	61.08%
Educational level of fathers	Below senior high school	58	16.48%
	Junior college and above	294	83.52%
Educational level of mothers	Below senior high school	56	15.91%
	Junior college and above	296	84.09%
Educational level of feeders	Below senior high school	106	30.11%
	Junior college and above	246	69.89%
Complications during gestational period or lactation of mothers	Yes	172	48.86%
	No	180	51.14%
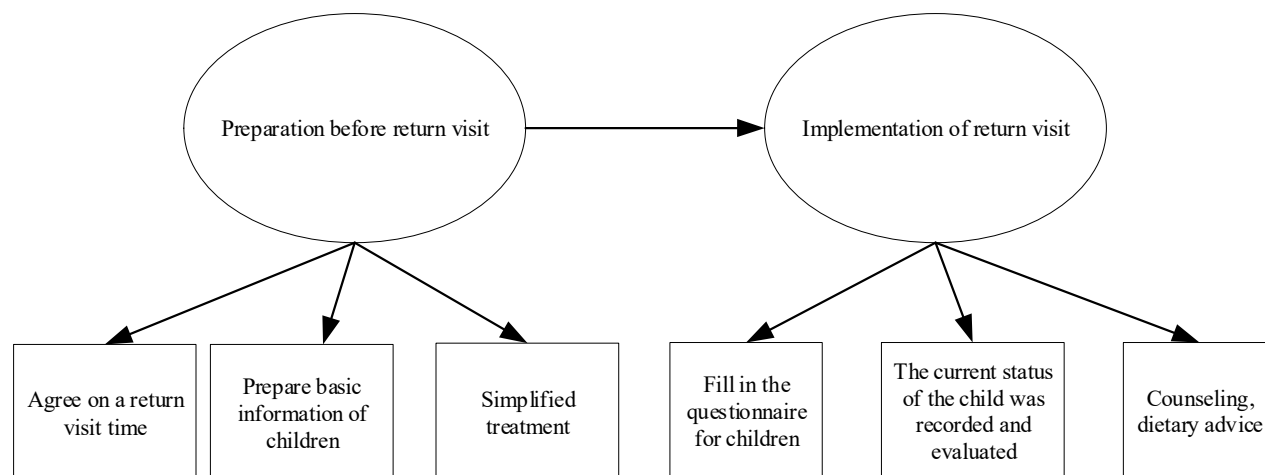
Fig. 1: Process extended intervention during follow-up revisit.
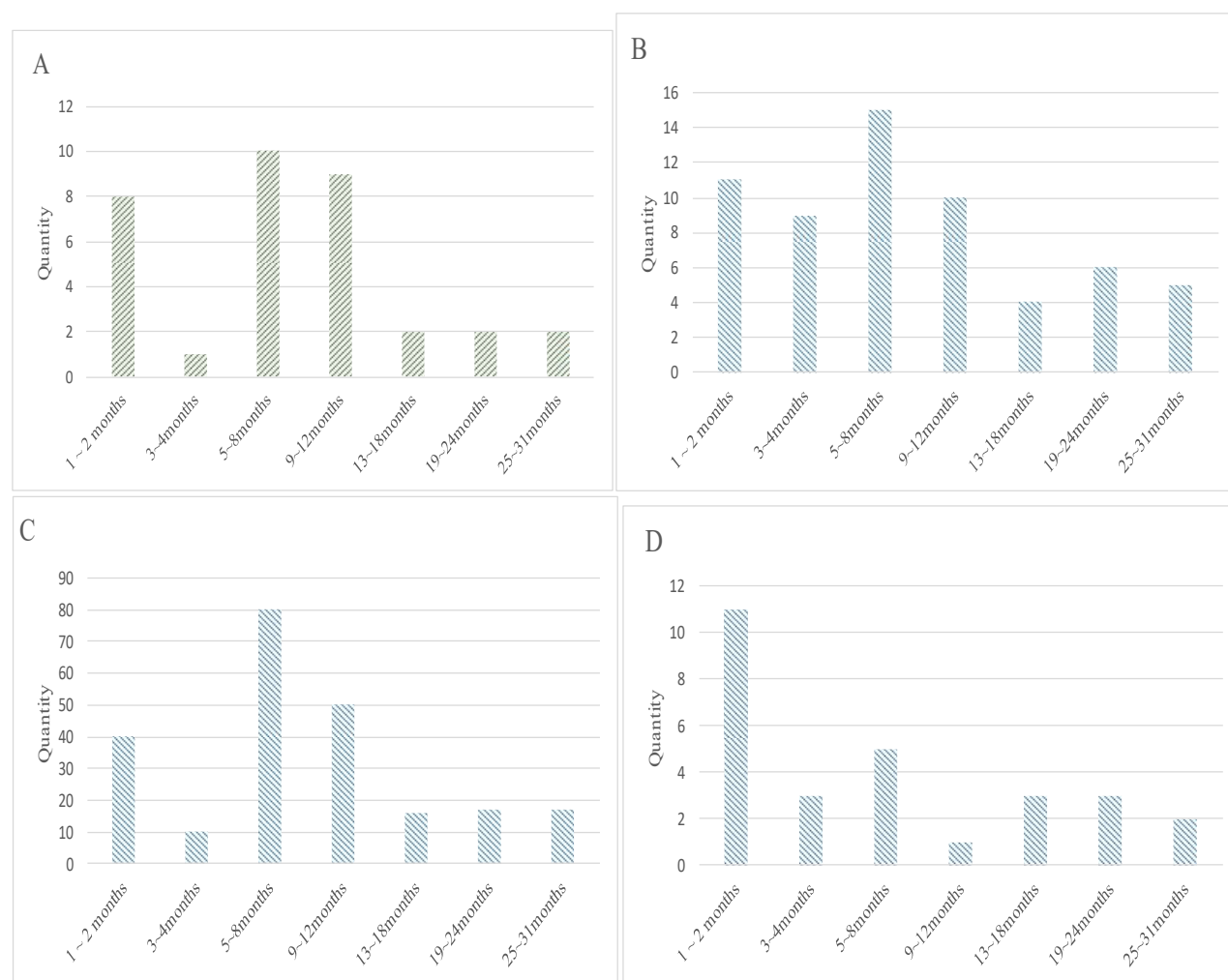
Fig. 2: Incidence of malnutrition.
Note: A showed the number of children with different months of age and muscle tension retardation as the initial symptom. B displayed the number of children with different months of age and height less than normal level as the initial symptom. C illustrated the number of children with different months of age and weight loss as the initial symptom. D presented the number of children with different months of age and intellectual retardation as the initial symptom.
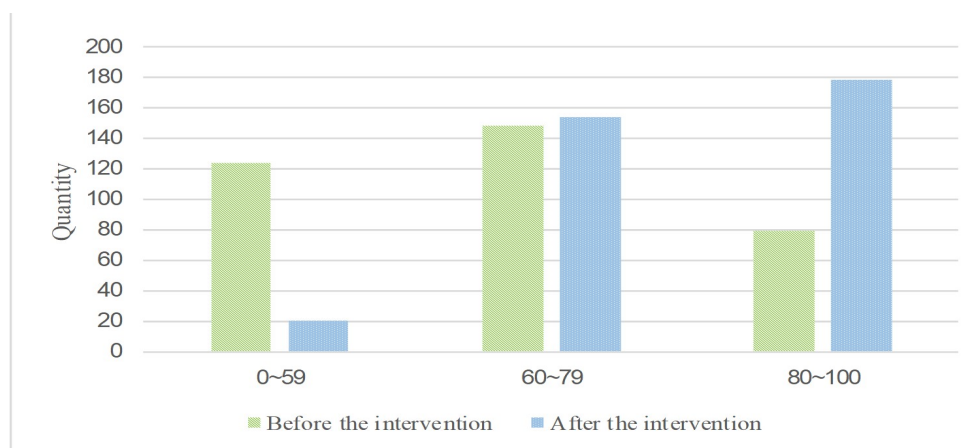
Fig. 3: The comparison of the first and second understanding of nutritional disease knowledge.

illustrated in fig. 3. After the intervention, there were 250 cases showing improvement in disease conditions and 102 cases with no improvement. The number of cases with effective management was 278, while 74 cases did not achieve effective management. As for follow-up compliance, there were 83 cases with standardized follow-up and 269 cases without. The number of cases with improved knowledge of nutritional disorders was 179, while 173 cases did not show improvement.

In contrast, the disease among 102 children was not improved. As displayed in Figure 3C below, there were 278 cases receiving effective management and 74 cases without receiving effective management. As presented in Figure 3D below, the number of the cases undergoing standard follow-up before and after intervention were 37 and 315, respectively. After intervention, 83 cases received standard follow-up and 269 didn't experience standard follow-up. The difference between the two assessment results demonstrated statistical significance ($P<0.05$). As demonstrated in Figure 3E below, there were 179 cases with improved understanding rate of nutritional disease knowledge and 173 cases with unimproved understanding rate of nutritional disease knowledge. The results of health education intervention were shown in detail in fig. 3 below.

DISCUSSION

Malnutrition tends to occur in children under 3 years old, which poses a serious threat to children's health and may even lead to child death if measures are not taken in time (Gong, 2022). Nutrition is to maintain life and promote the growth and development of children. Malnutrition is an invisible killer that seriously affects children's health, which can directly cause children's growth and development disorders (Tallman, 2022; Leidman, 2020). In recent years, clinical studies have shown that giving necessary nursing interventions to malnourished children can improve the health awareness rate of family members

and reduce the incidence of malnourished children (Petry, 2020). Therefore, our hospital gave necessary health education intervention measures to 352 children aged 0~3 years in this community. In this work, 352 malnourished and anemic children aged 0-3 years in Minhang Community of Shanghai were selected as test subjects, and the growth and development status of the children were analyzed in the form of questionnaire survey. Health education intervention was conducted after the first questionnaire survey, and the second questionnaire survey was conducted 6 months later. The results of two questionnaires were compared to analyze the effect of health intervention. From the results of the first questionnaire survey, the basic information statistics showed that 57.10% of the children were male and 42.90% were female. The proportion of boys suffering from malnutrition and anemia was slightly higher than that of girls. 116 children with anemia caused by malnutrition accounted for 32.95%, which was close to the anemia rate of children and adolescents in various provinces and cities (20%-40%). Among the 352 malnourished children, 70 cases were malnourished from January to February, 23 from March to April, 110 from May to August, 70 from September to December, 25 from 13 to 18 months, 28 from 19 to 24 months, and 26 from 25 to 31 months. The initial symptoms of malnutrition in 352 children were mainly concentrated in four aspects: lower than normal height, weight loss, low intellectual development, and low muscle tone. Among them, the total number of children with low muscle tone was 34 cases, the total number of children with lower than normal body length was 60 cases, the total number of children with weight loss was 230 cases, and the total number of children with low intellectual development was 28 cases. It can be observed that the main symptom of children with malnutrition is lower than normal body length. The causes of infant malnutrition are mainly related to improper diet, parents' education level and feeding methods. It has little to do with economic factors or lack of food. Infant period is mainly due to insufficient breast milk, and failed to add supplementary food in time or

artificial feeding is not scientific, can't guarantee the quality and quantity of adequate supply. Children entering early childhood, especially the only child's partial eating, picky eating phenomenon is more prominent, resulting in unbalanced diet nutrition, easy to cause malnutrition. In addition, some diseases and dysfunction of the digestive tract can also cause malnutrition. In short, children's malnutrition is caused by many factors, parents should give timely attention, especially in the diet and living habits to give correct guidance. Parents of young children should strengthen the education of scientific parenting knowledge, use computer nutrition meals, adjust diet scientifically and reasonably, achieve color, fragrance and taste, meet children's different nutritional needs, improve their appetite, and arrange timely and quantitative meals. In addition, dietary hygiene should be strengthened, digestive tract diseases and dysfunction should be reduced, comprehensive management of children's diseases should be strengthened and malnutrition should be effectively prevented and prevented fundamentally, to promote the healthy growth of children. Proper diet and parents' cultural knowledge are especially important. The diet structure is not reasonable. The diet is dominated by carbohydrates, and the content of protein and fat is low, which is an important cause of infant malnutrition. The disease factor is the most important factor leading to infant malnutrition. After illness, children's food intake and absorption are reduced, and nutritional deficiency and increased consumption will lead to malnutrition (Akomo, 2020). Unreasonable addition of complementary foods and low birth weight children often fail to catch up with normal growth in early childhood, leading to developmental delay of preschool children (Engidaye, 2019). Stunting is more difficult to correct in malnourished children than in the other two types. In conclusion, if necessary, health education interventions are given to malnourished children, their symptoms can be significantly improved and their families' awareness of scientific feeding knowledge can be significantly increased, which is very beneficial to the growth and development of children.

CONCLUSION

The initial symptoms of malnutrition in 352 children were mainly concentrated in four aspects: lower than normal height, weight loss, low intellectual development and low muscle tone. Health education intervention for children with malnutrition can effectively improve the condition of children, improve the health level of children, worthy of popularization and application. However, due to the limited sample size, the research scope should be further expanded in future studies.

ACKNOWLEDGEMENT

REFERENCES

Akomo P and Collins S. (2020). Comment on RUTF and correction of anaemia and iron deficiency in severe acute malnutrition. *ClinNutr*., **39**(9): 2935.

Al-Jawaldeh A, Taktouk M, Doggui R, Abdollahi Z, Achakzai B, Aguenaou H, Al-Halaika M, Almamary S, Barham R, Coulibaly-Zerbo F, Ammari LE, Elati J, Nishtar NA, Omidvar N, Shams MQ, Qureshi AB and Nasreddine L (2021). Are countries of the eastern mediterranean region on track towards meeting the world health assembly target for anemia? A review of evidence. *Int.J.Environ.Res. Public Health*, **18**(5): 2449.

Caicedo-Gallardo JD, Rivadeneira MF, Torres AL, Tello B, Astudillo F, Buitrón GJ and Moncayo AL (2021). Social capital and its relationship with malnutrition and anemia in children from rural coastal Ecuador. *Rural Remote Health*, **21**(4):6271.

Chiang CP, Chang JY, Wang YP, Wu YH, Wu YC and Sun A. (2020). Atrophic glossitis: Etiology, serum autoantibodies, anemia, hematinic deficiencies, hyperhomocysteinemia and management. *J. Formos Med. Assoc*., **119**(4): 774-780.

Chiang CP, Wu YC, Chang JY, Wang YP, Wu YH and Sun A (2020). Anemia, hematinic deficiencies, hyperhomocysteinemia and gastric parietal cell antibody positivity in atrophic glossitis patients with iron deficiency. *J. Formos Med. Assoc*., **119**(2): 587-594.

Chiang CP, Wu YH, Wu YC, Chang JY, Wang YP and Sun A. (2020). Anemia, hematinic deficiencies, hyperhomocysteinemia and serum gastric parietal cell antibody positivity in 884 patients with burning mouth syndrome. *J. Formos Med. Assoc*., **119**(4): 813-820.

Chiang ML, Wu YH, Chang JY, Wang YP, Wu YC and Sun A (2021). Anemia, hematinic deficiencies and hyperhomocysteinemia in gastric parietal cell antibody-positive and -negative burning mouth syndrome patients. *J. Formos Med. Assoc*., **120**(2): 819-826.

Clark LN, Helm MC, Higgins R, Lak K, Kastenmeier A, Kindel T, Goldblatt M and Gould JC (2018). The impact of preoperative anemia and malnutrition on outcomes in paraesophageal hernia repair. *Surg. Endosc*., **32**(11): 4666-4672.

Curi-Quinto K, Ortiz-Panozo E and López de Romaña D (2020). Malnutrition in all its forms and socio-economic disparities in children under 5 years of age and women of reproductive age in Peru. *Public Health Nutr*., **23**(S1): s89-s100.

Din ZU, Pervez L, Amir A, Abbas M, Khan I, Iqbal Z and Iqbal M (2018). Parasitic infections, malnutrition and anemia among preschool children living in rural areas of Peshawar, Pakistan. *Nutr. Hosp*., **35**(5): 1145-1152.

Djuardi Y, Lazarus G, Stefanie D, Fahmida U, Ariawan I and Supali T (2021). Soil-transmitted helminth infection, anemia, and malnutrition among preschool-age children in Nangapanda subdistrict, Indonesia. *PLoSNegl. Trop. Dis*., **15**(6): e0009506.

El-Shafie AM, Kasemy ZA, Omar ZA, Alkalash SH, Salama AA, Mahrous KS, Hewedy SM, Kotb NM, Abd El-Hady HS, Eladawy ES, Zeid MA, Abd El Hamid ME, Hemeda EH, El-Shafie MA, El-Meligy EA and Bahbah WA (2020). Prevalence of short stature and malnutrition among Egyptian primary school children and their coexistence with Anemia. *Ital. J. Pediatr*., **46**(1): 91.

Engidaye G, Melku M, Yalew A, Getaneh Z, Asrie F and Enawgaw B. (2019). Under nutrition, maternal anemia and household food insecurity are risk factors of anemia among preschool aged children in Menz Gera Midir district, Eastern Amhara, Ethiopia: A community based cross-sectional study. *BMC Public Health*, **19**(1): 968.

Gong Y, Xie L and Yu S (2022). Long-Term in-center nocturnal hemodialysis improves renal anemia and malnutrition and life quality of older patients with chronic renal failure. *ClinInterv. Aging*, **17**: 915-923.

Huang L, Liang P, Xu Y, Xu A and Wei Z (2021). Development of coagulation disorders, malnutrition, and anaemia and duration of virus shedding in COVID-19: Implications for disease mechanism and management. *Int. J. Clin. Pract*., **75**(9): e14353.

Islam GMR (2021). Inequality, chronic undernutrition, maternity, and diabetes mellitus as the determinant of anemia among ever-married women in Bangladesh. *BMC Public Health*, **21**(1): 310.

Jesson J, Dahourou DL, AmorissaniFolquet M, Malateste K, Yonaba C, N'Gbeche MS, Ouédraogo S, Mea-Assande V, Amani-Bossé C, Blanche S, Timité-Konan M, Leroy V and MONOD ANRS 12206 Study Group (2018). Malnutrition, growth response and metabolic changes within the first 24 months after art initiation in HIV-infected children treated before the age of 2 years in West Africa. *Pediatr. Infect. Dis J*., **37**(8): 781-787.

Jesus SR, Alves BP, Golin A, Mairin S, Dachi L, Marques A and Colpo E (2018). Association of anemia and malnutrition in hospitalized patients with exclusive enteral nutrition. *Nutr. Hosp*., **35**(4): 753-760.

Kulkarni R, Rajput U, Dawre R, Sonkawade N, Pawar S, Sonteke S, Varvatte B, Aathira KC, Gadekar K, Varma S, Nakate L, Kagal A and Kinikar A (2021). Severe malnutrition and anemia are associated with severe COVID in infants. *J. Trop. Pediatr*., **67**(1): fmaa084.

Leidman E, Humphreys A, Greene Cramer B, Toroitich-Van Mil L, Wilkinson C, Narayan A and Bilukha O. (2018). Acute malnutrition and anemia among rohingya children in kutupalong camp, Bangladesh. *JAMA*, **319**(14): 1505-1506.

Leidman E, Miah ML, Humphreys A, Toroitich-van Mil L, Wilkinson C, Chelang'atKoech M, Sebuliba H, Abu Bakr Siddique M and Bilukha O (2020). Malnutrition trends in Rohingya children aged 6-59 months residing in informal settlements in Cox's Bazar District, Bangladesh: An analysis of cross-sectional, population-representative surveys. *PLoS Med*., **17**(3): e1003060.

Lewis CA, de Jersey S, Seymour M, Hopkins G, Hickman I and Osland E (2020). Iron, vitamin B12, folate and copper deficiency after bariatric surgery and the impact on anaemia: A systematic review. *Obes. Surg*., **30**(11): 4542-4591.

Małyszko J, Tomaszuk-Kazberuk A, Dobrzycki K, Bachórzewska-Gajewska H, Zorawski M, Koc-Zorawska E, Kobus G and Dobrzycki S (2021). Vitamin D deficiency and anemia is highly prevalent and dependent on the etiology of heart failure: A pilot study. *Cardiol. J*., **28**(2): 262-270.

Mrimi EC, Palmeirim MS, Minja EG, Long KZ and Keiser J (2022). Malnutrition, anemia, micronutrient deficiency and parasitic infections among school children in rural Tanzania. *PLoSNegl. Trop. Dis*., **16**(3): e0010261.

Pandit P, Galande S and Iris F. (2021). Maternal malnutrition and anaemia in India: Dysregulations leading to the 'thin-fat' phenotype in newborns. *J. Nutr. Sci*., **11**: 10: e91.

Peña-Rosas JP, Mithra P, Unnikrishnan B, Kumar N, De-Regil LM, Nair NS, Garcia-Casal MN and Solon JA (2019). Fortification of rice with vitamins and minerals for addressing micronutrient malnutrition. *Cochrane Database Syst. Rev*., **2019**(10): CD009902.

Petry N, Nizamov F, Woodruff BA, Ishmakova R, Komilov J, Wegmuller R, Wirth JP, Arifdjanova D, Guo S and Rohner F (2020). Risk factors for anemia and micronutrient deficiencies among women of reproductive age-the impact of the wheat flour fortification program in Uzbekistan. *Nutrients*, **12**(3): 714.

Rahman MS, Mushfiquee M, Masud MS and Howlader T (2019). Association between malnutrition and anemia in under-five children and women of reproductive age: Evidence from Bangladesh demographic and health survey 2011. *PLoS One*, **14**(7): e0219170.

Rivadeneira MF, Moncayo AL, Tello B, Torres AL, Buitrón GJ, Astudillo F, Fredricks TR and Grijalva MJ. (2020). A multi-causal model for chronic malnutrition and anemia in a population of rural coastal children in ecuador. *Matern. Child Health J*., **24**(4): 472-482.

Schechter A, Gafter-Gvili A, Shepshelovich D, Rahamimov R, Gafter U, Mor E, Chagnac A and Rozen-Zvi B (2019). Post renal transplant anemia: severity, causes and their association with graft and patient survival. *BMC Nephrol*., **20**(1): 51.

Sumbele IUN, Otia OV, Francis L, Bopda OSM, Ebai CB, Ning TR, Kimbi HKK and Nkuo-Akenji T (2021). Confounding influences of malnutrition and Plasmodium falciparum and Schistosomahaematobium

infections on haematological parameters in school children in Muyuka, Cameroon. *BMC Infect. Dis*., **21**(1): 477.

Tallman PS, Valdes-Velasquez A and Sanchez-Samaniego G (2022). The "Double Burden of Malnutrition" in the Amazon: dietary change and drastic increases in obesity and anemia over 40 years among the Awajún. *Ecol. Food Nutr*., **61**(1): 20-42.

Varghese JS and Stein AD (2019). Malnutrition among women and children in India: Limited evidence of clustering of underweight, anemia, overweight, and stunting within individuals and households at both state and district levels. *Am. J. Clin. Nutr*., **109**(4): 1207-1215.

Wu YC, Wu YH, Chang JY, Wang YP, Kuo YS and Sun A (2020). Anemia, hematinic deficiencies, hyper-homocysteinemia, and gastric parietal cell antibody positivity in atrophic glossitis patients with vitamin B12 deficiency. *J. Formos. Med. Assoc*., **119**(3): 720-727.

Zhang Z, Yin D, Chen H, Liu B, Liu X, Shan W, Hua J, Qi Z, Zhang Y, Zhang Q, Chen Y, Wang L, Guo Y and Sun Z (2020). Evaluation of anemia, malnutrition, mineral, and bone disorder for maintenance hemodialysis patients based on bioelectrical impedance vector analysis (BIVA). *Clin. Exp. Nephrol*., **24**(12): 1162-1176.

Pak. J. Pharm. Sci., Vol.36, No.4, July 2023, pp.1063-1071

1071