# MINISTRY OF EDUCATION MINISTRY OF HEALTH

# AND TRAINING

**NATIONAL INSTITUTE OF NUTRITION**

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**THE NUTRITIONAL STATUS AND EFFECTIVENESS OF ENHANCING BIBOMIX ON NUTRITIONAL STATUS OF CHILDREN 6-11 MONTHS OLD IN QUANG XUONG DISTRICT, THANH HOA PROVINCE (2018-2020)**

**Specialization: Nutrition**

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**SUMMARY OF DOCTORAL DISSERTATION**

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The thesis will be defended at the Institute-level doctoral thesis grading committee at the National Institute of Nutrition

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**The thesis can be found at:**

**-Vietnam National Library**

**- Library of the National Institute of Nutrition**

**LIST OF DISCLOSED RESEARCH RELATED**

**TO THE THESIS THEME**

**1. Tran Thi Minh Nguyet,** Tran Thuy Nga, Nguyen Thi Viet Ha, Tran Khanh Van, Nguyen Thi Lan Phuong, Le Thi Thuy Dung, Dang Thi Hanh (2023). The effectiveness of multi - micronutrient powder fortification combined with nurturing care communication on anthropometric status of children aged 6 - 11 months in some rural communities of Thanh hoa province, Viet nam. Vietnam Preventative Journal Volum 33, issue 4 – 2023, pages 117 – 123.

**2. Tran Thi Minh Nguyet,** Tran Thuy Nga, Nguyen Thi Viet Ha, Tran Khanh Van, Nguyen Thi Lan Phuong, Le Van Thanh Tung, Nguyen Thi Luong Hanh (2023). Malnutrition status and associated factors of infants aged 6-11 months old in some rural communes of Thanh hoa province. Vietnam medical journal Volum 531, issue 1, pages 345 – 350.

**3. Tran Thi Minh Nguyet**, Tran Thuy Nga, Nguyen Thi Viet Ha, Tran Khanh Van, Nguyen Thi Lan Phuong, Le Thi Thuy Dung, Le Thi Loan (2024). Iron deficiency anemia in children aged 6-11 months old and some related factors in sevral rural communes in Thanh Hoa province, Vietnam. Journal of Preventive Medicine, volume 20, number 1, 2024.

**INTRODUCTION**

According to UNICEF, in 2023, 22.3% of children under 5 years old estimated being stunted and 6.8% being wasted, of which 340 million children suffering from hidden hunger due to lack of vitamins and minerals. In Vietnam, the prevalence of stunting for children under 5 years old was 19.6%, zinc deficiency - 58%, anemia in children 6-11 months old - 25.6%.

There have been many nutritional intervention studies in children using micronutrients, nutrition education and communication with significant improvement of nutritional status and micronutrients deficiency. The age group of children from 6 to 11 months old is noted with high prevalence of malnutrition, related to the fact that complementary diets provided not adequate child's needs of nutrients, that might be seen popular in poor, rural areas with limited economic conditions, knowledge, health care and nutrition practices. However, there were very few nutritional intervention programs for this age group. Therefore, we conducted research: ***"*** ***The nutritional status and effectiveness of enhancing bibomix on nutritional status of children 6-11 months old in quang xuong district, thanh hoa province (2018-2020)”*** aims to:

**Objectives:**

1. Describe the nutritional status, diet and some related factors of children 6-11 months old in 10 communes of Quang Xuong district, Thanh Hoa province, 2018 - 2019.

2. Evaluate the effectiveness of the multi-micronutrient enhancement intervention using Bibomix health protection food for children 6-11 months old on anthropometric status, micronutrient status, and body composition; in coordinating directly health education and communication to child caregivers.

**New contributions of the thesis:**

- One of the few research projects combining health education communication (health education) with micronutrient fortification with Bibomix recommended by the Institute of Nutrition and WHO after 6 months and 12 months of intervention with improvement of anthropometric status and micronutritient for children 6-11 months old, helping to promptly supplement current developmental needs and compensate for deficiencies in previous stages.

- Compared to previous studies with using micronutrient- products fortification, our study showed better results on children's length, weight, and hemoglobin level, proving the importance of the intervention using Bibomix products with a combination of directly health education and communication to child caregivers.

- This is the first study in Vietnam to use the stable isotope method to assess body composition (BC) for children 6 months, 12 months and 18 months old, contributing to providing scientific evidence for study of nutritional status in this age group.

- Multi-micronutrient supplementation intervention under the Bibomix multi-micronutrient powder package containing 15 essential vitamins and minerals, as recommended by WHO and the Institute of Nutrition, as an optimal solution for areas with moderate and high prevalence of malnutrition and micronutrient deficiency, serving well for prevention or supporting treatment of children with malnutrition and micronutrient deficiency.

**Structure of the thesis:**

The thesis consits of 140 pages: Introduction and Objectives of study: 3 pages. Literature review: 33 pages ; Subjects and Methods of study: 27 pages ; Research results 40 pages; Discussions: 33 pages. Conclusion and recommendations : 4 pages. The thesis has 19 figures, 36 tables, 175 references.

CHAPTER I. LITERATURE REVIEW

1.1. Nutritional and developmental characteristics of children

At the age of 6 months old, a child faces with the transition in nutrition from exclusive breastfeeding to complementary feeding. In addition to the daily supplement diet not providing enough energy, vitamins and minerals, along with poor child care, children are at high risk of malnutrition, digestive diseases and infectious diseases.

1.2. The role of micronutrients and educational communication to improve the quality of complementary foods for children

Micronutrients includes vitamins and mineral salts with many different roles and functions. It is vital for the enzyme system, cell division, immune function, control and prevention of infections, increase intestinal tissue recovery, and increment nearby insusceptibility.

Nutritional education and communication is considered to be the most important solution in improving knowledge, changing the behavior of the community and mothers, promoting breastfeeding and improving the quality of nutritious supplemental foods appropriate for each child's age.

1.3. Malnutrition status and micronutrient deficiency in children

Malnutrition and micronutrient deficiency in children are still significant public health concerns. It is estimated that 22.3% of children under 5 years old globally are stunted and 6.8% are wasted, of which 340 million children suffer from hidden hunger due to lack of vitamins and minerals. In Vietnam, the prevalence of stunting in children under 5 years old is 19.6%, vitamin A deficiency is 8.9%, zinc deficiency rate is 58%, and anemia rate in children 6-11 months old is 25.6%. remains at an average level, affecting public health.

1.4. Studies on the micronutrient supplementation effect

Currently, many studies on micronutrient intervention and active communication on young children showed significant interventional effect on anthropometric status, micronutrient composition and body composition after 6 months and 12 months. intervention.

1.5. Remaining issues and required research

As high prevalence of malnutrition and micronutrient deficiency in rural areas and high-risk age groups is still remaining, one of the effective solutions recommended by WHO and the Institute of Nutrition is multi-micronutrient supplementation combined with active communication, that helps promptly provide sources of micronutrients to prevent and support treatment for children with malnutrition.

Evaluation of body composition using the Deuterium stable isotope technique according to IAEA guidelines as is the first study on a group of children aged 6-11 months in Vietnam, which can provide more scientific evidence for evaluating intervention effectiveness.

**CHAPTER 2- RESEARCH SUBJECTS AND METHODS**

2.1. Subjects, location and time of research

- Subjects*:*

*+ Inclusive criteria for intervention study: Children aged 6 – 11 months old with signed commitment form by mother/caregivers*.

*+Exclusive criteria : Children with malnutrition weight/height Zscore < -3 or with severe anemia (Hb <70g/L) or severe infections or using less than 75% of the required products.*

- *Location:* The study was conducted in 10 communes in Quang Xuong district, Thanh Hoa Province, Vietnam. The intervention group of 5 communes included Quang Hoa, Quang Hop, Quang Phuc, Quang Truong, and Quang Van. Control group of 5 communes including Quang Khe, Quang Linh, Quang Long, Quang Ngoc, Quang Nhan.

**- *Research duration***: The intervention period was 12 months, from February 2019 to April 2020.

2.2. Research design

- Cross-sectional descriptive study was conducted to describe nutritional status and some factors related to malnutrition.

- Population-based intervention study (randomized controlled, double-blind and assessed before - after intervention).

- The intervention group received the MNPs Bibomix multi-micronutrient package (1 package at a time, 3-4 packages/week, 15 packages/month for 12 months), supplemented with complementary foods, and the control group used the Placebo package, these two packages were made the same to avoid discrepancies when deployed in the community. The date and year of manufacture (March 2021 for the intervention group and September 2021 for the control group) was marked outside each package.

2.3. Sample size

***Sample size for cross-sectional study***, apply formula for a research population to calculate the minimum sample size:

|  |  |
| --- | --- |
| n = | Z 2 (1-α/2) p (1 – p) |
| d2 |

n: sample size; Z 2 (1-α/2) = 1,96 (confident interval 95%); d: absolute error 0,05 (5%); p: prevalence of stunting, anemia. Required number of children for anthropometric analysis was 347 for anemia 319 children. An additional 10% dropped out, which is 352 children, rounding up to 360 children.

***Sample size for community intervention study:***

Apply formula to estimate sample size:

2δ2 (Z­­­­1-α/2 + Z1-β/2 )2

(µ0 - µa)2

Sample size formula: n =

With: n: required sample size; α: Type 1 error, estimated for 5%. (Z­­­­1-a/2 =1,96); β: Type 2 error, estimated for 10%, (Z­­­­1-β/2 = 1,28); µ0 - µa: Difference in mean value; δ: Standard deviation of the mean value

The sample size for anthropometric analysis was 150 children/group; Hb analysis was 59 children/group; zinc was 101 children/group. Together, combining the above indicators, the minimum sample size required was 150 children/group to participate in the intervention trial. Estimated 20% of child dropout. So the sample size for one research group was 180 subjects, the sample size for two groups was 360 subjects.

For the evaluation of body composition, the sample size comprised 77 children per group, resulting in a total of 154 children across the two study groups. In terms of dietary assessment, each group consisted of 70 children, aggregating to 140 children for the two groups combined.

The composition of each group was determined by the anthropometric status, gender, and age group of the children, aiming for a total of 180 children per group. This included a specific subgroup of 77 children aged 6 months, designated for the evaluation of body composition.

2.4. Research Indicators and Variables

***General Information:*** This includes variables such as the child’s age, ethnicity, and any medical conditions experienced in the preceding two weeks, encompassing symptoms like fever, diarrhea, and acute respiratory infections. Additional variables include the mother's education level, her occupation, and the total number of children and people residing in the household…

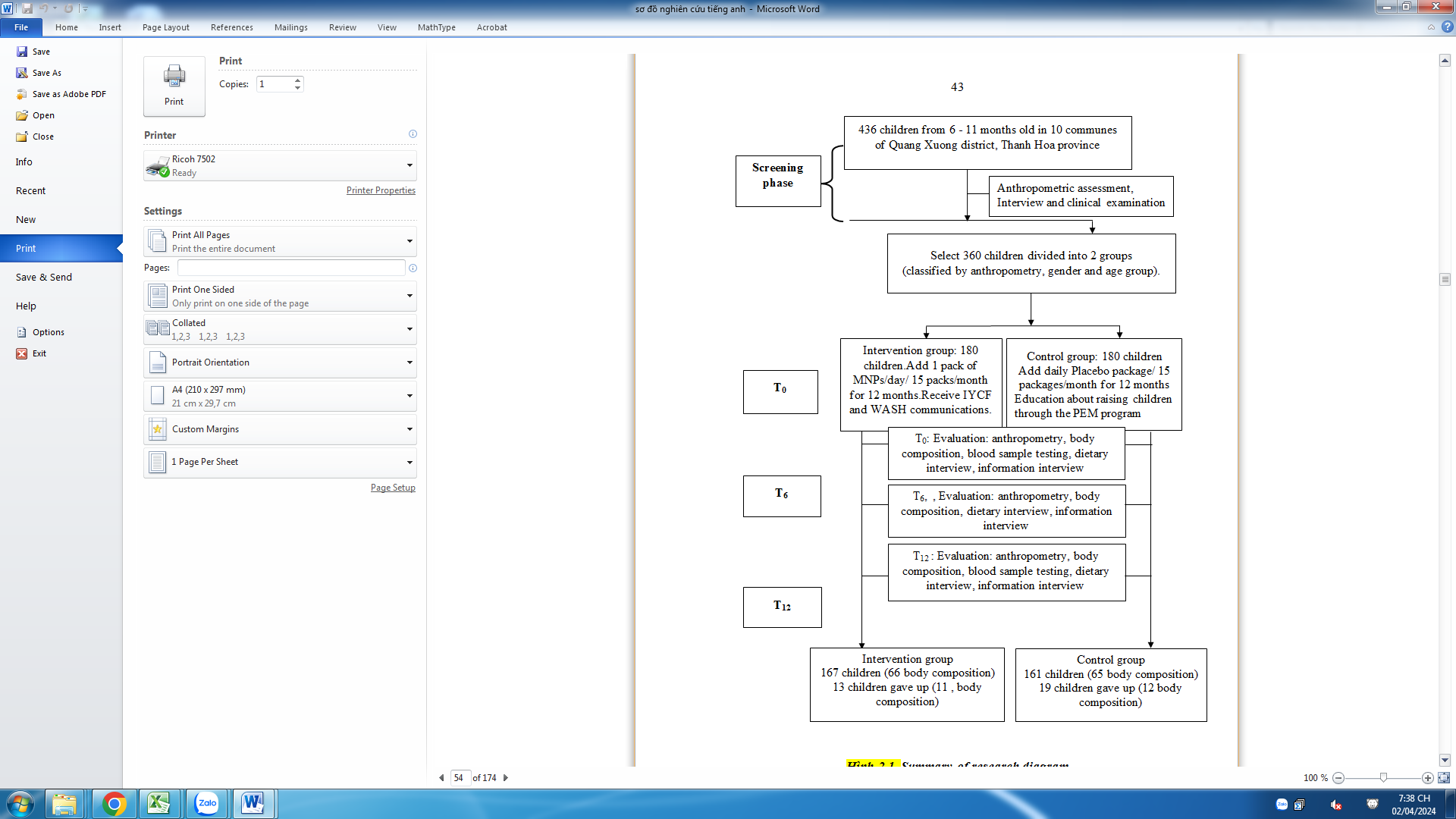
*Nutritional Status Assessment:* in accordance with the guidelines of WHO 2006.

*Hematological Index:* *Anemia* is identified when the concentration of hemoglobin <110g/L. *Iron deficiency* is defined as Ferritin <12 (μg/L) and CRP ≤ 5 (mg/L) or Ferritin concentration >30 (μg/L) and CRP >5 (mg/L). *Zinc deficiency* is characterized by a serum zinc concentration <<9,9µmol/L.

*Body Composition Index, Fat Mass [FM] and Fat-Free Mass [FFM]):* The Total Body Water (TBW) was assessed using the Deuterium stable isotope dilution technique, adhering to the guidelines of the International Atomic Energy Agency (IAEA).

*Dietary Evaluation*: This is conducted through a 24-hour dietary recall method, where participants are asked to record their food intake from the previous day. The nutritional value of these diets is then determined using the Vietnam Food Composition Table, as published by the Institute of Nutrition under the Ministry of Health in 2016.

2.5. Implement research



Hình 2.1. Summary of research diagram

2.6. Data Analysis

Anthropometric Data Processing: The anthropometric data were processed using the WHO Anthro software, version 2006. Statistical Software Utilization: The analysis of data was carried out using SPSS software, version 20.0

***Statistical Tests Employed***: Various statistical tests were applied in the analysis, including the Kolmogorov-Smirnov test for distribution assessment, Chi-Squared test (χ²-test) or Fisher's exact test for categorical data, Paired t-test, and Independent t-test for comparing means, and the Mann-Whitney U Test and Wilcoxon test for non-parametric data.

***Intervention Effectiveness Evaluation:*** ARR Index (Absolute Risk Reduction) measures the absolute decrease in risk of a certain event occurring as a result of the intervention; NNT Index (Number Needed to Treat) indicate the number of patients that need to be treated to prevent one additional bad outcome; Risk Ratio (RR) measures of the probability of an event occurring in the intervention group compared to a control group; Adjusted Results - calculated as RR\* (95% Confidence Interval) for qualitative variables and as mean (± SEM, Standard Error of the Mean) for quantitative variables.

2.7. Research Ethics

The study was approved by the Ethical Review Board in Biomedical Research of the Institute of Nutrition No. 259/VDD-QLKH on June 15, 2018.

CHAPTER 3. RESEARCH RESULTS

**3.1. Anthropometric status and some related factors of the child**

***Figure 3.1. The prevalence of malnutrition in the pediatric population (n=360)***

***Figure 3.2. The distribution of iron deficiency anemia prevalence among children. (n=360)***

In total 360 children, the prevalence of anemia was categorized as follows: 14 children, or 3.9% of the participants, were found to have moderate anemia; 86 children, representing 23.9%, had mild anemia; and the total number of children diagnosed with anemia was 100, accounting for 27.8% of the study population. Additionally, 59 children, equivalent to 16.4% of the participants, were identified with iron deficiency. Out of these, 39 children, or 10.8% of the total, were suffering from iron deficiency anemia.

**Table 3.1. The logistic regression model is employed to predict various factors associated with stunting.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors acting autonomously as risks** | | **β** | **OR** | **CI 95%** | **p** |
| Age group | *6 month* | - | 1 | | - |
| *7-11 t* *month* | 1,31 | 3,71 | 1,67 – 8,22 | **0,001** |
| Diarrhea | *No* | - | 1 | | **-** |
| *Yes* | 1,30 | 3,67 | 1,50 – 8,97 | **0,004** |
| Administration of micronutrient supplements during gestation | *Yes* | - | 1 | | - |
| *No* | 0,94 | 2,55 | 1,09 – 6,01 | **0,032** |
| Total family income | *≤ 5 million/month* | - |  | 1 | **-** |
| *> 5 million/month* | 1,95 | 7,00 | 3,16 – 15,52 | **< 0,001** |

*1: Reference group, multivariate regression*

There was a statistically significant difference in malnutrition status in children's age group, diarrhea status, mothers' micronutrient supplementation during pregnancy, and total family income (p < 0.05).

**Table 3.2. The multivariable logistic regression model is utilized to predict a range of factors associated with anemia.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors acting autonomously as risks** | | **β** | **OR** | **95%CI** | **p** |
| Iron deficiency | *Yes* | 2,44 | 11,52 | 5,86 - 22,64 | **< 0,001** |
| *No* |  | 1 | |  |
| Total family income | *> 5 triệu/tháng* |  | 1 | |  |
| *≤ 5 triệu/tháng* | 1,16 | 3,18 | 1,52 - 6,65 | **0,002** |

*1: Reference group, multivariate regression*

The difference was statistically significant in the iron deficiency group; group with total family income over 5 million/month (with (p < 0.05).

**Table 3.3. The nutritional constituents present in the diets of children categorized by gender**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group of boys (n = 65)** | **Group young girls (n = 75)** | **common group** | **Recommendations\*** |
| **Mean** *±* **SD** | **Mean** *±* **SD** | **Mean** *±* **SD** |
| Energy (kcal) | 569,7 *±* 90,4 | 558,2 *±* 80,8 | 563,5 *±* 85,3 | 600-700 |
| Protein (g) | 17,9 *±* 3,3 | 17,8 *±* 3,1 | 17,9 *±* 3,2 | 18-20 |
| Lipid (g) | 26,5 *±* 4,3 | 25,6 *±* 3,5 | 26,0 *±* 3,9 | 22-31 |
| Glucid (g) | 87,2 *±* 15,9 | 85,9 *±* 18,4 | 86,5 *±* 17,3 | 95-110 |
| Vitamin A (mcg) | 380,7 *±* 142,1 | 381,6 *±* 140,1 | 381,2 *±* 140,6 | 400 |
| Calcium (mg) | 212,8 *±* 5,2 | 212,6 *±* 5,5 | 212,7 *±* 5,3 | 400 |
| Iron (mg) | 3,7 *±* 1,5 | 3,6 *±* 1,3 | 3,7 *±* 1,4 | 8,5-9,4 |
| Zinc (mg) | 3,1 *±* 0,6 | 3,2 *±* 0,7 | 3,1*±* 0,6 | 4,1 |

*\** *Nutritional recommendations for children 6-8 months and 9-11 month.*

The results of the responsive rate of energy, Protein, Lipid, Glucid, Vitamin A, Calcium, Iron, Zinc are lower than the recommended needs.

**3.2.** **Evaluate the effectiveness of intervention on children's anthropometric status**

**Table 3.4. Change in child's weight index after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention** | **Control group** | **CT-C** | ***pa*** |
| ***After 6 months intervention (kg) n=173 n =168*** | | |  |  |
| Before intervention(T0) | 7,71 ± 0,85 | 7,68 ± 0,89 | 0,03 | 0,738 |
| After 6 months(T6) | 9,59 ± 0,97 | 9,28 ± 0,98 | 0,31 | 0,004 |
| Difference T6 - T0 | 1,88 ± 0,79 | 1,60 ± 0,76 | 0,28 | 0,001 |
| Difference\* T6 - T0 | 1,96 ± 0,10 | 1,67 ± 0,10 | 0,29 | 0,001\* |
| *pb* | **< 0,001** | **< 0,001** |  |  |
| ***After 12 months intervention (kg) n=167 n =161*** | | |  |  |
| Before intervention(T0) | 7,74 ± 0,84 | 7,68 ± 0,90 | 0,06 | 0,520 |
| After 12 months(T12) | 11,72 ± 0,86 | 11,38 ± 0,99 | 0,34 | 0,001 |
| Difference T12 - T0 | 3,98 ± 1,04 | 3,71 ± 0,97 | 0,27 | 0,015 |
| Difference\* T12 - T0 | 4,04 ± 0,12 | 3,71 ± 0,12 | 0,33 | <0,001\* |
| *pb* | **< 0,001** | **< 0,001** |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis*

After 6 and 12 months, the effect of intervention on children's weight was clearly seen (p < 0.01).

**Table 3.5. Change in children's Z-score CN/T after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention** | **Control group** | **CT-C** | ***pa*** |
| *After 6 months intervention n=173 n =168* | | |  |  |
| Before intervention(T0) | -0,55 ± 1,03 | -0,59 ± 1,09 | 0,04 | 0,716 |
| After 6 months(T6) | -0,13 ± 0,90 | -0,41 ± 0,94 | 0,31 | **0,006** |
| Difference T6 - T0 | 0,42 ± 0,85 | 0,19 ± 0,83 | 0,23 | **0,011** |
| Difference\* T6 - T0 | 0,49 ± 0,09 | 0,23 ± 0,09 | 0,26 | **<0,001\*** |
| *pb* | **< 0,001** | **< 0,001** |  |  |
| *After 12 months intervention n=167 n =161* | | |  |  |
| Before intervention(T0) | -0,51 ± 1,01 | -0,58 ± 1,10 | 0,07 | 0,575 |
| After 12 months(T12) | 0,54 ± 0,65 | 0,29 ± 0,81 | 0,25 | **0,003** |
| Difference T12 - T0 | 1,05 ± 1,05 | 0,87 ± 0,93 | 0,18 | 0,099 |
| Difference\* T12 - T0 | 1,12 ± 0,09 | 0,85 ± 0,09 | 0,27 | **<0,001\*** |
| *pb* | **< 0,001** | **< 0,001** |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis*

After 6 monthsvà After 12 monthscho kết quả thấy rõ ảnh hưởng của intervention lên Z-score CN/T (p < 0,001).

**Table 3.6. Changing the child's lying length after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention** | **Control group** | **CT-C** | ***pa*** |
| ***After 6 months intervention (cm) n=173 n =168*** | | |  |  |
| Before intervention(T0) | 67,35 ± 2,31 | 67,41 ± 2,88 | -0,06 | 0,830 |
| After 6 months(T6) | 74,65 ± 2,18 | 74,39 ± 2,58 | 0,26 | 0,329 |
| Difference T6 - T0 | 7,30 ± 1,68 | 6,99 ± 1,64 | 0,31 | 0,083 |
| Difference\* T6 - T0 | 7,29 ± 0,20 | 7,06 ± 0,21 | 0,23 | 0,160\* |
| *pb* | **< 0,001** | **< 0,001** |  |  |
| ***After 12 months intervention (cm) n=167 n =161*** | | |  |  |
| Before intervention(T0) | 67,33 ±2,34 | 67,38 ± 2,92 | -0,05 | 0,882 |
| After 12 months(T12) | 81,51 ± 2,28 | 80,88 ± 2,47 | 0,63 | **0,017** |
| Difference T12 - T0 | 14,17 ± 2,26 | 13,50 ± 2,57 | 0,67 | **0,012** |
| Difference\* T12 - T0 | 14,48 ± 0,31 | 13,87 ± 0,29 | 0,61 | **0,006\*** |
| *pb* | **< 0,001** | **< 0,001** |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis*

After 12 months, the effect of intervention on lying length in children was clearly seen (p<0.05).

**Table 3.7. Change in children's Z-score CD/T after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention** | **Control group** | **CT-C** | ***pa*** |
| ***After 6 months intervention n=173 n =168*** | | |  |  |
| Before intervention(T0) | -0,83 ± 1,09 | -0,84 ± 1,23 | -0,01 | 0,950 |
| After 6 months(T6) | -0,87 ± 0,99 | -0,98 ± 1,07 | 0,11 | 0,301 |
| Difference T6 - T0 | -0,03 ± 0,67 | -0,14 ± 0,68 | 0,11 | 0,142 |
| Difference\* T6 - T0 | -0,01 ± 0,08 | -0,10 ± 0,08 | 0,11 | 0,161\* |
| *pb* | **< 0,001** | **< 0,001** |  |  |
| ***After 12 months intervention n=167 n =161*** | | |  |  |
| Before intervention(T0) | -0,82 ± 1,09 | -0,82 ± 1,24 | 0 | 0,976 |
| After 12 months(T12) | -0,58 ± 0,85 | -0,79 ± 1,00 | 0,21 | **0,034** |
| Difference T12 - T0 | 0,24 ± 0,89 | 0,02 ± 0,95 | 0,22 | **0,036** |
| Difference\* T12 - T0 | 0,35 ±0,09 | 0,13 ± 0,09 | 0,22 | **0,005\*** |
| *pb* | **< 0,001** | **< 0,001** |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis*

After 12 months, the effect of the intervention on the CD/T Z-score was clearly seen (p < 0.01).

**Table 3.8. Effective disease prevention on stunting malnutrition**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention** | **Control group** | ***p*** |
| ***After 6 months intervention (n%) n=146 n =139*** | | |  |
| Malnutrition and stunting | 1 (0,7%) | 8 (5,8%) | **0,015** |
| No malnutrition and stunting | 145 (99,3%) | 131 (94,2%) |
| ARR% (95%CI) | 5,1 (1,0; 9,2) | |  |
| NNT (95%CI) | 19,7 ( 10,9 ; 102,7) | |  |
| RR (95%CI) | 0,12 (0,02 ; 0,94) | | **0,015** |
| RR (95%CI)\* | 0,02 (0,01 ; 0,70) | | **0,030** |
| ***After 12 months intervention (n%) n=141 n =134*** | | |  |
| Malnutrition and stunting | 1 (0,7%) | 8 (6,0%) | **0,015** |
| No malnutrition and stunting | 140 (99,3%) | 126 (94,0%) |
| ARR% (95%CI) | 5,3 ( 1,0 ; 9,5) | |  |
| NNT (95%CI) | 19,0 (10,5; 98,3) | |  |
| RR (95%CI) | 0,12 (0,02 ; 0,94) | | **0,015** |
| RR (95%CI)\* | 0,12 (0,01 ; 1,02) | | **0,052** |

*RR (95%CI)\* Derived from comprehensive multivariate regression analysis*

The results after 6 months clearly show the impact of prevention on stunting in children (p < 0.05).

**Table 3.9 Effective treatment support for stunting malnutrition**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention** | **Control group** | ***p*** |
| ***After 6 months intervention (n%) n = 27 n = 29*** | | |  |
| Malnutrition and stunting | 16 (59,3%) | 22 (75,9%) | 0,184 |
| No malnutrition and stunting | 11 (40,7%) | 7 (24,1%) |
| ARR% (95%CI) | 16,6 ( -7,6 ; 40,8) | |  |
| RR (95%CI) | 0,78 (0,54 ; 1,14) | | 0,184 |
| RR (95%CI)\* | 0,18 (0,02 ; 1,56) | | 0,118 |
| ***After 12 months intervention (n%) n = 26 n = 27*** | | |  |
| Malnutrition and stunting | 8 (30,8%) | 17 (63,0%) | **0,019** |
| No malnutrition and stunting | 18 (69,2%) | 10 (37,0%) |
| ARR% (95%CI) | 32,2 (6,8 ; 57,6) | |  |
| NNT (95%CI) | 3,1 ( 1,7 ; 14,8) | |  |
| RR (95%CI) | 0,49 (0,26 ; 0,93) | | **0,019** |
| RR (95%CI)\* | 0,11 (0,02 ; 0,78) | | **0,028** |

*RR (95%CI)\* Derived from comprehensive multivariate regression analysis*

The effectiveness of treatment support was 32.2%. After 12 years, the impact of treatment support on stunting in children was clearly seen (p < 0.05).

**3.3.** **Assess the impact on anemia and micronutrient status (specifically iron and zinc) deficiencies, in children aged 6-11 months.**

**Table 3.10. Modifications in the hemoglobin levels of children subsequent to the intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n*= 167)** | **Control group**  **(*n*=161)** | **CT-C** | ***pa*** |
| Before intervention(T0) | 113,80 *±* 8,25 | 115,18 *±* 8,97 | -1,38 | 0,145 |
| After 12 months (T12) | 121,78 *±* 8,36 | 119,40 *±* 8,70 | 2,38 | **0,012** |
| Difference T12 - T0 | 7,97 *±* 7,23 | 3,56 *±* 11,12 | 4,41 | **<0,001** |
| Difference\* T12 - T0 | 8,22 *±* 1,20 | 3,86 *±* 1,26 | 4,36 | **<0,001\*** |
| *pb* | **< 0,001** | **< 0,001** |  |  |

*p\* Derived from comprehensive multivariate regression analysis.*

After 12 months, the effect of intervention on hemoglobin concentration in children was clearly seen (p < 0.001).

**Table 3.11 Successful intervention in preventing anemia among children**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n*=118)** | **Control group**  **(*n*=119)** | ***p*** |
| Presence of anemia | 0 (0,0%) | 8 (6,7%) | **0,004** |
| Absence of anemia | 118 (100,0%) | 111 (93,3%) |
| ARR% (95%CI) | 6,7 ( 2,2 ; 11,2) | |  |
| NNT (95%CI) | 14,9 (8,9 ; 44,9) | |  |

*ARR absolute risk reduction after intervention. NNT number of children requiring intervention to reduce 1 case of disease after intervention.*

The effectiveness of preventive intervention in the intervention group reduced the disease rate by 6.7% compared to the control group.

**Table 3.12. Hiệu quả hỗ trợ điều trị bệnh đến tình trạng thiếu máu**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n* = 49)** | **Control group**  **(*n* = 42)** | ***p*** |
| Presence of anemia | 5 (10,2%) | 12 (28,6%) | **0,025** |
| Absence of anemia | 44 (89,8%) | 30 (71,4%) |
| ARR% (95%CI) | 18,4 (2,3 ; 34,5) | |  |
| NNT (95%CI) | 5,4 (2,9 ; 36,3) | |  |
| RR (95%CI) | 0,36 (0,14 ; 0,93) | | **0,025** |
| RR (95%CI)\* | 0,04 ( 0,003 ; 0,55) | | **0,015** |

*RR (95%CI)\*:Derived from comprehensive multivariate regression analysis*

The intervention effectiveness was 18.4%. After 12 months, the impact of supporting anemia treatment in children with anemia before intervention was clearly seen (p < 0.05).

**Table 3.13. Thay đổi nồng độ ferritin của trẻ sau intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n*=167)** | **Control group**  **(*n*=161)** | **CT-C** | ***pc*** |
| Before intervention(T0) | 24,17 (17,31; 32,95) | 21,89 (14,83; 33,46) | 2,28 | 0,202 |
| After12 months(T12) | 34,02 (23,56; 50,62) | 26,44 (19,40; 35,5) | 7,58 | **< 0,001** |
| Difference T12 - T0 | 8,49 (1,00; 16,61) | 5,52 (-7,40; 13,40) | 2,97 | **0,001** |
| Difference\* T12 - T0 | 9,96 ± 1,83 | 2,52 *±* 1,91 | 7,44 | **<0,001** |
| *pd* | **< 0,001** | **0,002** |  |  |

*pc : accreditation Mann-Whitney U Test; pd: accreditation Wilcoxon test.*

After 12 months, the effect of intervention on ferritin levels in children was clearly seen (p < 0.001).

**Table 3.14. Successful prevention of iron deficiency in pediatric populations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n*= 144)** | **Control group**  **(*n*= 129)** | ***p*** |
| Deficiency in iron | 0 (0,0%) | 10 (7,8%) | **0,001** |
| Absence of iron deficiency | 144 (100,0%) | 119 (92,2%) |
| ARR% (95%CI) | 7,8 (3,1; 12,4) | |  |
| NNT (95%CI) | 12,9 (8,1; 31,1) | |  |

*ARR absolute risk reduction after intervention. NNT number of children requiring intervention to reduce 1 case of disease after intervention.*

The effectiveness of preventive intervention is 7.8%, a statistically significant difference in the effectiveness of iron deficiency prevention (p < 0.001).

**Table 3.15. Alterations in the zinc levels in children following intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Group intervention**  **(n= 167)** | **Control group**  **(n=161)** | **CT-C** | **pa** |
| Before intervention(T0) | 8,95 ± 1,62 | 9,01 ± 1,51 | -0,06 | 0,752 |
| After 12 months(T12) | 10,62 ± 0,97 | 10,26 ± 1,31 | 0,36 | **0,005** |
| Difference T12 - T0 | 1,67 ± 1,33 | 1,26 ± 1,47 | 0,41 | **0,008** |
| Difference\* T12 - T0 | 1,74 ± 0,14 | 1,36 ± 0,14 | 0,38 | **0,001\*** |
| pb | **< 0,001** | **< 0,001** |  |  |

*p\* Derived from comprehensive multivariate regression analysis.*

After 12 months, the effect of the intervention on zinc concentrations in children was clearly seen (p < 0.01).

**Table 3.16. Successful prevention of zinc deficiency**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n*=43)** | **Control group**  **(*n*=38)** | ***p*** |
| Deficiency in zinc | 1 (2,3%) | 10 (20,8%) | **< 0,001** |
| Absence of zinc deficiency | 42 (97,7%) | 38 (79,2%) |
| ARR% (95%CI) | 18,5 (6,2; 30,8) | |  |
| NNT (95%CI) | 5,4 (3,2 ; 16,2) | |  |
| RR (95%CI) | 0,11 (0,01 ; 0,84) | | **< 0,001** |
| RR (95%CI)\* | 0,03 ( 0,002 ; 0,51) | | **0,016** |

*RR (95%CI)\*:Derived from comprehensive multivariate regression analysis*

The effectiveness of preventive intervention was 18.5%, after 12 months the effect of preventive intervention on zinc deficiency was clearly seen (p < 0.001).

**Table 3.17. Efficiently aids in the remediation of zinc deficiency**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Group intervention**  **(*n*=124)** | **Control group**  **(*n*=113)** | ***p*** |
| Deficiency in zinc | 22 (17,7%) | 55 (48,7%) | < 0,001 |
| Absence of zinc deficiency | 102 (82,3%) | 58 (51,3%) |
| ARR% (95%CI) | 31,0 (19,5 ; 42,3) | |  |
| NNT (95%CI) | 1,3 (1,2 ; 1,5) | |  |
| RR (95%CI) | 0,36 (0,24 ; 0,56) | | < 0,001 |
| RR (95%CI)\* | 0,14 (0,07 ; 0,30) | | < 0,001 |

*RR (95%CI)\*:* *Derived from comprehensive multivariate regression analysis*

As a result, after 12 months, the effect of therapeutic intervention on zinc deficiency was clearly seen (p < 0.001).

**3.4. Assessing the efficacy of an intervention on the body composition of children aged 6-11 months, employing the stable isotope technique.**

**Table 3.18. Alteration in the FFM composition of the child's body following intervention**

| **Index** | **Group intervention** | **Control group** | **CT-C** | ***pa*** |
| --- | --- | --- | --- | --- |
| ***After 6 months intervention (kg)* (*n*=70) (*n*=68)** | | |  |  |
| Before intervention(T0) | 6,14 ± 0,66 | 6,18 ± 0,70 | -0,04 | 0,683 |
| After 6 months(T6) | 7,41 ± 0,67 | 7,31 ± 0,83 | 0,1 | 0,398 |
| Difference T6 - T0 | 1,28 ± 0,42 | 1,12 ± 0,44 | 0,16 | **0,035** |
| Difference\* T6 - T0 | 1,25 ± 0,10 | 1,12 ± 0,09 | 0,13 | **0,088\*** |
| *pb* | **< 0,001** | **< 0,001** |  |  |
| ***After 12 months intervention (kg)* (*n*=66) (*n*=65)** | | |  |  |
| Before intervention(T0) | 6,11 ± 0,65 | 6,19 ± 0,71 | -0,08 | 0,509 |
| After 12 months(T12) | 9,56 ± 0,87 | 9,30 ± 0,87 | 0,26 | 0,085 |
| Difference T12 - T0 | 3,45 ± 0,79 | 3,12 ± 0,92 | 0,33 | **0,029** |
| Difference\* T12 - T0 | 3,18 ± 0,18 | 2,86 ± 0,18 | 0,32 | **0,019\*** |
| *pb* | **< 0,001** | **0,006** |  |  |

*p\*Derived from comprehensive multivariate regression analysis.*

After 12 months, the effect of intervention on fat-free mass in children was clearly seen (p<0.05).

**Table 3.19. Alteration in the proportion of fat mass in children subsequent to intervention.**

| **Index** | **Group intervention** | **Control group** | **CT-C** | ***pa*** |
| --- | --- | --- | --- | --- |
| ***After 6 months intervention (%)* (*n*=70 ) (*n*=68)** | | |  |  |
| Before intervention(T0) | 19,97 *±* 8,14 | 19,74 *±* 8,09 | 0,23 | 0,867 |
| After 6 months(T6) | 18,39 *±* 6,97 | 17,89 *±* 6,61 | 0,5 | 0,666 |
| Difference T6 - T0 | -1,58 *±* 4,34 | -1,85 *±* 5,09 | 0,27 | 0,738 |
| Difference \* T6 - T0 | 0,81 *±* 1,01 | 0,08 *±* 0,97 | 0,73 | 0,338\* |
| *pb* | **0,003** | **0,004** |  |  |
| ***After 12 months intervention (%)* (*n*=66 ) (*n*=65)** | | |  |  |
| Before intervention(T0) | 19,74 *±* 8,26 | 20,01 *±* 8,02 | -0,27 | 0,849 |
| After 12 months(T12) | 17,33 *±* 5,46 | 18,50 *±* 6,45 | -1,17 | 0,263 |
| Difference T12 - T0 | -2,41 *±* 5,40 | -1,43 *±* 6,97 | -0,98 | 0,374 |
| Difference \* T12 - T0 | -0,02 *±* 1,42 | 0,63 *±* 1,29 | -0,65 | 0,049\* |
| *pb* | **<0,001** | **< 0,001** |  |  |

*p\* Derived from comprehensive multivariate regression analysis.*

After 12 months of intervention, the effect on the percentage of fat mass in children was clearly seen (p<0.05).

CHAPTER IV. DISCUSSION

4.1. Description of Nutritional Status, Diet, and Associated Factors in Children Aged 6-11 Months at 10 communes of Quang Xuong district, Thanh hoa Province, 2018 - 2019.

The study's results indicate that the average weight and height of the children in the examined group are below the recommended benchmarks set by the World Health Organization (WHO) in their 2006 guidelines. The rate of anemia and iron deficiency is still at a level of public health significance according to the WHO classification.

The research revealed several key insights into child malnutrition: Increasing Prevalence of Stunting with Age, this could be attributed to the fact that older children have higher nutritional needs, which are not adequately met, leading to growth deficiencies. Impact of Maternal Micronutrient Supplementation as children born to mothers who regularly supplemented with micronutrients during pregnancy had a 0.39 times lower risk of malnutrition. This highlights the crucial role of prenatal nutrition in child health. Diarrhea as a Contributing Factor: Diarrhea emerged as one of the primary causes of malnutrition among children. The condition adversely affects the digestive system, impairing the child's ability to absorb nutrients, thus exacerbating malnutrition. Income and Nutritional Access: a correlation between family income and child nutrition and anemia. Higher-income families generally have better access to nutritional knowledge and nutritious foods, which contributes to improved health outcomes in children.

The study also showed that ingredients in children's diets were lower than recommendations such as Calcium and Iron concentration (responsive level was only from 41.2% to 53.4%). Therefore, improving both the quality and quantity of daily complementary foods for children and raising awareness of parents and caregivers are important interventions to help children prevent malnutrition and iron deficiency anemia.

4.2. Evaluating the effectiveness of the intervention on anthropometric status, micronutrient deficiency, and body composition.

*Effectiveness of the Intervention on Children's Anthropometric Status:* On average, the anthropometric indices and the rates of supporting treatment and prevention for SAM in the intervention group were more effective than the control group. The supplementation of multi-micronutrients in the intervention group led to increased absorption and metabolic rates, as well as enhanced appetite in children. This may have contributed to a statistically significant increase in weight in the intervention group compared to the control group.

***The effectiveness on hemoglobin concentration and the prevalence of anemia, iron deficiency anemia in children:***The results of this study showed that after 12 months, the intervention group had increased average hemoglobin concentration, ferritin concentration, decreased prevalence of anemia, decreased prevalence of iron deficiency, and improved effectiveness in preventing and treating anemia and iron deficiency compared to the control group. These findings aligned with other studies on multi-micronutrient fortification and health communication, highlighting their effectiveness in addressing anemia and iron deficiency. Thus, expanding this intervention to rural, mountainous, and disadvantaged areas could help reduce the risk of these conditions in young children.

***The effectiveness on zinc concentration and prevalence of zinc deficiency in the studied children:*** Zinc levels showed the most noticeable improvement in both concentration and reduction of overall zinc deficiency rates in both the intervention and control groups. However, the intervention group exhibited significantly higher effectiveness compared to the control group because it included additional essential micronutrients, including zinc. These findings are consistent with previous studies by other authors, such as Nguyen Thanh Ha (2012) in Gia Binh district, Bac Ninh province, and Nguyen Thi Thuy Hong (2013) in Luc Ngan district, Bac Giang province.

**4.3. Evaluating the intervention's effectiveness on body composition of children aged 6-11 months using stable isotope techniques.**

The significant increase in average body fat-free mass (FFM) after 6 and 12 months in the intervention group compared to the control group highlights the importance of enhancing micronutrient supplementation in household diets combined with nutritional and childcare counseling for children's total body composition measured by stable isotope techniques. Overall, the data obtained from our study indicated that Vietnamese infants aged 6 to 12 months participating in the research have body composition values: FM, FFM, as well as trends in changes in the percentage of FM and FFM in the body that are comparable to available global reference data.

This serves as a scientific foundation to explore new research directions aimed at improving nutritional status, particularly addressing stunting in young children in the future.

**4.4. Some limitations**

Lack of observed effectiveness in treating iron deficiency, disease prevention, and treating underweight conditions after 12 months of intervention. Inability to assess the cessation phase to demonstrate the sustainable effectiveness of enhancing multi-micronutrient nutrition using Bibomix health protective products, in conjunction with direct health communication for children aged 6-11 months, on anthropometric status, micronutrient status, and body composition.

Despite incorporating variables into the regression analysis to mitigate confounding factors and obtain true effectiveness values, it remains challenging to control for all confounding variables in the study.

CONCLUSION

**1. Description of the nutritional status, diet, and some related factors of children aged 6-11 months in 10 communes of Quang Xuong district, Thanh Hoa province, from 2018 to 2019:**

- The rate of stunting malnutrition was 17.8%, underweight was 9.2%, and wasting was 4.2%. Children in the age group of 7-11 months, those who suffered from diarrhea, or mothers without micronutrients supplementation, or those from low-income families had a higher rate of stunting compared to others, with p < 0.05.

- The prevalence of anemia was 27.8%, iron deficiency was 16.4%, and iron deficiency anemia was 10.8%. Children with iron deficiency, and those from families with a total monthly income of less than 5 million VND had a higher rate of anemia compared to others, with p < 0.001.

**2. Assess the effectiveness of nutritional intervention with Bibomix Health Protective Food in 6-11 Month Old Children on anthropometric status, micronutrient status, and body composition alongside direct health communication with caregivers.**

**2.1. Effectiveness on Children's Anthropometric Status:Đánh giá hiệu quả can thiệp lên tình trạng nhân trắc của trẻ**

After 6 months, the intervention showed a clear influence on the children's weight, length, weight-for-height Z-score, and height-for-age Z-score, aiding in the prevention of stunting (p<0.05). Following 12 months, the intervention had a significant effect on recumbent length, height-for-age Z-score, supporting the treatment of stunting (p< 0.05). The specific details are:

**2.2. To evaluate the effectiveness on anemia and micronutrient status (iron and zinc deficiency) in children aged 6-11 months**

- The results demonstrated a clear impact of the intervention on hemoglobin concentration, CRP, ferritin, and serum zinc levels in children (p<0.05). There was an effective treatment of anemia in children who were anemic prior to the intervention (p< 0.05); the intervention was also effective in preventing and treating zinc deficiency in children (p< 0.05), specifically:

**2.3. To evaluating the effectiveness of the intervention on the body composition of children aged 6-11 months using stable isotope techniques.**

Results after controlling for confounding factors pre-intervention showed a clear impact after 6 months on the children's fat-free mass and the average percentage of body fat after 12 months.

RECOMMENDATIONS

1. The project demonstrated that active communication to improve knowledge of nutritional practices and hygiene practices in healthcare of children for mothers, combining multi-micronutrient fortification in complementary meals for children is effective. The results of improving nutritional status, FM, FFM and micronutrients in the community can be considered a relatively effective solution to reduce the prevalence of malnutrition, anemia, iron deficiency, and zinc deficiency. Thus, it's recommended to extend this approach to other regions sharing similar socio-economic and geographical characteristics as the area studied.

2. Further in-depth research and evaluation of effectiveness post-intervention are needed to provide comprehensive and sustainable scientific evidence regarding the impact of multi-micronutrient supplementation combined with proactive communication on children's nutritional status, growth, development, and functions (immunity, cognition, etc.). This is to offer more appropriate recommendations for early intervention strategies within the first 1000 days of life for young children in rural Vietnam.