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Research Article

Use of Micronutrient Powder in At-Home Foods for Young Children (6-18 Months): A Feasibility Study

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Abstract

Background and Objective: Micronutrient deficiency is prevalent among young children in low and middle-income countries. Micronutrient powder (MNP) has gained popularity for treatment and prevention of micronutrient deficiency due to its ease of use and low cost. This study aimed to evaluate the feasibility of incorporating MNP into foods consumed at-home by young children.

Methodology: A total of 25 children aged 6-18 months consumed a packet of MNP per day for 10 days. Data on compliance, acceptance and preference for MNP were obtained through observation and interviews with the parents. **Results:** All parents showed a high level of compliance and reported no observed side effects of MNP use. Most parents reported easy mixing of MNP with foods (92%) no change in the taste (88%), smell (92%) or color (94%) of mixed foods and improved appetite in children (88%). The majority of parents (76%) were willing to purchase MNP. Children preferred MNP added to mashed fruits/fruit juices (96.8%), infant formula/whole milk (93.6%) and infant cereals/cereal products (92.8%). **Conclusion:** This study showed that it was feasible to incorporate MNP into foods consumed by young children at home. Fortification of at-home foods with MNP could be an effective strategy to improve the health and nutrition of children.

Key words: Micronutrient supplementation, infants, young children, home-food fortification

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Child undernutrition is highly prevalent in low and middle-income countries and has severe consequences for child health and survival¹. Nearly half of all deaths in children under 5 years old are attributable to undernutrition. It is also responsible for one-fifth of diseases that burden this age group^{2,3}. Globally, 13.9% of children under 5 years old were underweight, 23.2% stunted and 7.4% wasted⁴. However, the prevalence rates of underweight, stunting and wasting among children under 5 years old in the developing countries were 20.5, 37.3 and 7.8%, respectively⁵. In the middle East, a WHO⁶ report showed that 5.5, 15.8 and 7.4% of children under 5 years old were underweight, stunted and wasted, respectively. Tsigga and Grammatikopoulou⁷ reported that the prevalence rates of underweight, stunting and wasting among Palestinian children under 5 years were 4.7, 10.9 and 2.9%, respectively.

Globally, vitamin and mineral deficiencies affect more than two billion people⁸. Worldwide, at least half of children under 5 years old suffer from one or more micronutrient deficiencies⁹. Iron, vitamin A and zinc deficiencies are ranked among the top 10 leading causes of death in developing countries¹⁰. Micronutrient deficiency has been associated with alterations in child growth. Castejon *et al.*¹¹ reported that among children aged 24-84 months, 5.9% of stunted children and 2.9% of underweight children were anemic, while vitamin A deficiency occurred in 2.9% of stunted and 1.4% of underweight children. Abdeen *et al.*¹² reported that 47, 44, 91 and 83% of Palestinian children aged 36-59 months had inadequate intake of vitamin A, folate, zinc and calcium, respectively. Zakout¹³ assessed the relationship between stunting and zinc deficiency among toddlers (aged 1-3 years) and showed that 70.1% of stunted children had zinc deficiency, compared with 11.6% non-stunted toddlers.

The nutrition guidance expert advisory group strongly recommends home fortification of foods with micronutrients to improve the nutritional status of children under 5 years old¹⁴. In recent years, fortification of homemade food with micronutrients provided in powdered form, crushable tablets and lipid-based spreads has been recognized as a possible strategy to prevent micronutrient deficiencies in vulnerable groups, such as young children who cannot swallow tablets. The use of MNP has gained popularity since its inception in the late 1990's due to ease of use and low cost¹⁵. The MNP, distributed in single-dose packets is a powder containing essential vitamins and minerals that can be sprinkled onto any semi-solid food at home to increase the content of essential nutrients in the child's diet during this period¹⁶.

De Pee *et al.*¹⁷ recommended three key factors that could improve the acceptance of MNP. First, the packaging should be culturally appropriate, clear and self-explanatory with regard to content, target group, frequency and means of use. Second, clear information, education and communication (IEC) materials should be provided together with a good social marketing campaign and adequate training for those who will provide the product. Third, the mother or caretaker should receive the product with explicit instructions on its proper use to increase the chance of acceptance. Non-adherence to these recommended factors could affect the quantity, quality and compliance rate of intake of food mixed with MNP. The present study was conducted to assess the compliance and acceptance of MNP and preference for at-home foods mixed with MNP.

MATERIALS AND METHODS

Design and participants: The study was conducted in October–November, 2015. One primary health care clinic of the United Nations Relief and Work Agency (UNRWA) was selected randomly among 20 UNRWA clinics in the Gaza Strip. A list of 75 children aged 6-18 months was obtained from the clinic (15 from each age group of 6, 9, 12, 15 and 18 months old). The children were subsequently screened for study eligibility, i.e., the children were full term (>37 weeks of gestational age), had no history of chronic disease (e.g., failure to thrive, metabolic or endocrine diseases), did not have any congenital or neurological disorders, were not born to diabetic mothers and had no diarrhea or vomiting within the last 2 weeks. Upon screening, 68 children were eligible for the study, of which 5 children from each age group (N = 25) were randomly selected using a table of random numbers. All parents agreed to participate and were required to sign informed consent forms before data collection.

Characteristics of micronutrient powder: The micronutrient powder used in this study was "Mixme™" multiple micronutrient powder, which is manufactured by DSM Nutritional Products Europe, Switzerland. It consists of 10 vitamins (A, D, E, B1, B2, B6, niacin, B9, B12 and C) and 5 minerals (zinc, copper, iodine, iron and selenium)¹⁸.

Measurements: Each child was provided with one sachet of MNP day⁻¹ for 10 days and observed over this period. Specific instructions on the mixing of MNP were provided to parents. The researcher identified five food groups (infant formula or whole milk, infant cereal or cereal products, mashed fruit or fruit juice, cooked vegetable and pasta, rice, or

potatoes) commonly consumed by children in these age groups to be mixed with MNP. Parents were required to mix MNP with a single food daily. For example, on the first day, mothers were instructed to mix MNP with infant formulas (i.e., cow's milk-based or soy-based formula), or whole milk for those who did not use infant formula. On the second day, mothers were asked to add MNP to one type of infant cereal (i.e., rice-based or wheat-based cereal) or cereal product (i.e., wheat, rice or corn) for older children. Mashed fruits or fruit juices (e.g., apple, banana or guava) and cooked vegetables (e.g., carrots, spinach, cauliflower or green beans) were used on the third and fourth days, respectively. On the fifth day, mothers were asked to mix MNP with pasta, rice, or potatoes. This same process was repeated over the next five days.

Compliance was measured by counting the empty MNP sachets that the parents returned for each child at the end of the study. The compliance rate was estimated by dividing the total number of consumed sachets by the total number of distributed sachets. Data on acceptance and preference for MNP were obtained from parents through an interviewer-administered questionnaire. Acceptance of MNP was assessed using ten items on instructions for use; change in the smell, color or taste food, the child's appetite and the parent's willingness to buy MNP. The children's preference for five food groups (infant formula/whole milk, infant cereal/cereal products, pasta/rice/potatoes, mashed fruit/fruit juice and cooked vegetables) mixed with MNP was measured using a 5-point Likert scale (1 = 'Extremely dislike' to 5 = 'Extremely like'). The ranking of preference score for each food group was calculated by multiplying the percentage of responses in each category (EDL-EL) by its respective score (1-5), adding up these products and dividing by 5.

Ethics approval: The study protocol was approved by the Ethics Committee for Research Involving Human Subjects (JKEUPM) of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, as well as the Helsinki Ethics Committee of the Gaza Strip. Permission to conduct the study in the UNRWA clinics was obtained from the Health Affairs Center of the UNRWA in the Gaza Strip.

Statistics: The data were analyzed using the statistical package for the social sciences (SPSS) for Windows, version 22. Frequencies and percentages were used to describe the data on compliance, acceptance and preference for MNP-fortified foods.

RESULTS

This study included 25 children aged 6-18 months. Boys and girls composed 52 and 48% of the subjects, respectively. A high compliance rate was observed, with all parents reporting that the children consumed all sachets of MNP distributed over 10 days.

Table 1 shows the acceptance of the MNP. A majority of parents reported that the instructions for the use of the MNP were clear and easy to follow (96%) and most did not experience any problems with mixing the MNP into food (92%). None of the parents reported changes in tooth color or black stool in children using the MNP. Most parents reported no change in the smell (92%), color (96%) or taste of foods upon adding the MNP (88%). All parents reported no change in their children's liking or disliking to foods after adding the MNP. A high proportion of parents (88%) reported that their children had improved appetite after using the MNP. None of the children was reported to have any symptom of vomiting or diarrhea while using the MNP. Approximately 76% of parents indicated that they were willing to purchase the MNP if it was available in the market.

Table 2 presents children's preference among foods mixed with MNP. All parents reported that their children either "Like" or "Extremely like" MNP mixed with all food groups except cooked vegetables. Approximately 84% of parents reported that their children "Extremely like" MNP mixed with mashed fruits or fruit juices. A rating of "Extremely like" was also reported for MNP mixed with infant formula or whole milk (68%), infant cereals or cereal products (64%) and pasta, rice or potatoes (24%). For cooked vegetables, 72% of parents reported that their children "Like" MNP mixed with cooked vegetables, while 28% reported "Neutral". Mashed fruit or fruit juices were ranked the most preferred foods (96.8%), followed by infant formula milk or whole milk (93.6%), whereas cooked vegetables were ranked the least liked foods (74.4%).

DISCUSSION

Compliance with micronutrient supplementation is important for the prevention and treatment of undernutrition among young children as undernutrition can have adverse consequences on child growth and development¹⁹⁻²¹. It has been reported that micronutrient supplements in syrups or drops are less effective than other forms due to poor compliance. A possible explanation is the side effect of iron in the micronutrient drops or syrups such as constipation,

Table 1: Acceptance of micronutrient supplement powder (N = 25)

Variables	No. of frequencies	Percentage
Instructions for use		
Easy to follow	24	96
Difficult to follow	1	4
Mixing problems		
Yes	2	8
No	23	92
Change in tooth or stool color		
Yes	0	0
No	25	100
Change in smell of food		
No change	23	92
Slight change	2	8
Much change	0	0
Change in color of food		
No change	24	96
Slight change	1	4
Much change	0	0
Change in taste of food		
No change	22	88
Slight change	3	12
Much change	0	0
Change in liking or disliking of selected food		
No change	25	100
Liked less	0	0
Liked more	0	0
Children's appetite		
No change	3	12
Better than before	22	88
Worse than before	0	0
Vomiting or diarrhea		
Yes	0	0
No	25	100
Willing to buy the MNP		
Yes	19	76
No	0	24
Maybe	6	0

Table 2: Children's preference of foods mixed with micronutrient supplement powder (N = 25)

Food types	Percentages					Rank of preference (%)
	EDL	DL	N	L	EL	
Infant formula milk/whole milk	0	0	0	32	68	93.6
Mashed fruit/fruit juice	0	0	0	16	84	96.8
Cooked vegetables	0	0	28	72	0	74.4
Infant cereals/cereal products	0	0	0	36	64	92.8
Pasta, rice or potatoes	0	0	0	76	24	84.8

EDL: Extremely dislike, DL: Dislike, N: Neutral neither like nor dislike, L: Like, EL: Extremely like. Scores range from 1- 5 for all items, with the highest value (5) indicating EL. Rank of preference is calculated by multiplying the percentage of responses in each category (EDL-EL) by its respective score (1-5), adding up these products and dividing by 5

nausea, vomiting and diarrhea²²⁻²⁴. Iron drops, which are usually more concentrated, require careful monitoring to prevent risk of overdose²⁵. In addition, iron could produce a metallic taste and dark stains on the teeth, which could further reduce compliance with the micronutrient

supplementation^{23,26,27}. Micronutrient powder contains a lipid-encapsulated coating that prevents iron from dissolving into food and therefore it does not change the color or taste of the food or produce iron-related side effects²⁸. Similar to the studies of Lundeen *et al.*²⁹, Hirve *et al.*³⁰ and Rah *et al.*³¹, the

present study revealed that there was a high level of compliance with the use of a micronutrient supplement in powder form. This finding supports the use of micronutrient powder as an option to increase the effectiveness of micronutrient supplementation programs in preventing and controlling micronutrient deficiencies among infants and young children^{16,27,32}.

Acceptance of MNP was generally high in this study, although there were parents who reported difficulties in following the instructions for MNP use and mixing the MNP with foods. These problems can be resolved through training of health professionals to provide support to caregivers on the use of MNP and the importance of MNP in preventing micronutrient deficiency in their children³³. Similar to study by Mongolia³⁴, parents in the present study reported willingness to continue using the MNP, perhaps due to ease of use, observed increases in appetite and lack of side effects in their children.

This study showed that children had higher preferences for MNP mixed with fruits and milk than with cooked vegetables and pasta, rice or potatoes. Mashed fruits and fruit juices with MNP were very well liked by the majority of children, which may be associated with the human preference for sweet tastes³⁵. Several studies have demonstrated that fortification of milk and milk products with iron microcapsules did not change the appearance, flavor, mouthfeel or overall preference of the products^{16,32}. Cooked vegetables were the least liked MNP-mixed food by infants and young children as vegetables are generally less preferred by children, perhaps due to the taste and less exposure at home^{36,37}. The increasing price of vegetables in Palestine³⁸ could also contribute to lesser access to and consequently lesser consumption of vegetables, particularly among low-income households³⁹. It is also possible that the MNP was not mixed or dissolved properly in cooked vegetables and pasta, rice or potato dishes, such that the powder was noticeable in these foods.

CONCLUSION AND FUTURE RECOMMENDATIONS

The present study showed that fortification of food with MNP at home commonly consumed by Palestinian infants and young children was feasible as indicated by high compliance to, acceptance of and preference for MNP-mixed foods. This study provides the groundwork for future efforts to improve the health and nutrition of infants and young children in Palestine through home-fortification using MNP.

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