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Does parental nutritional education ensure proper nutritional status in infants?

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ABSTRACT

Introduction: Proper nutrition is extremely important at all stages of human life. Nutritional programming states that either an excess or deficiency of nutrients during the first 1000 days of a child's life can alter their metabolism and affect their health later in life. Despite widespread access to information on infant nutrition, parents still need to correct their feeding mistakes. Therefore, the aim of this study was to evaluate the impact of parental nutrition education on the nutritional status of children during their first year of life and to check whether these changes are still visible after 12 months.

Materials and methods: The follow-up study included a group of parents of 168 Polish infants. Their parents were randomly assigned to 1 of 2 groups: the intervention group received intensive mobile nutritional education for 1 year, while the control group received no intervention. The children were assessed 12 months after the end of parental participation.

Results: Our study showed that parental nutritional education influenced, among other things, the body mass index (BMI) z-score (the difference between the groups was 0.991) and the micro- and macronutrient intake of the children. The influence was still visible 12 months after the end of the study.

Conclusions: The final results of our study showed that proper nutritional education could improve the nutritional status of children at the population level.

Keywords: child nutrition; early childhood nutrition; nutritional programming; nutritional intervention; human health.

INTRODUCTION

Proper nutrition is extremely important at all stages of a person's life. Providing the right amount of macronutrients, minerals, and vitamins in the diet helps maintain good health and condition and protects against many diet-related diseases, such as obesity, cardiovascular disease, and cancer [1, 2, 3, 4, 5, 6, 7, 8]. According to the concepts of nutritional programming, nutrition from an early age is particularly important. Nutritional programming states that either an excess or deficiency of nutrients during the first 1000 days of a child's life can alter their metabolism and affect their health later in life [1, 2, 3]. This has critical implications for adult health [1, 2, 3]. Nutritional programming evaluates the relationship between childhood malnutrition and the prevalence of: cardiovascular disease, osteoporosis, obesity, hypertension, insulin resistance, impaired glucose tolerance, and type 2 diabetes in adulthood [4, 5, 6, 7, 8]. Because proper nutrition is one of the most important factors in early childhood development, it profoundly affects a child's susceptibility to many diseases. Proper nutrition of children cannot be ensured without adequate nutrition knowledge of parents.

Despite parents' general access to nutritional knowledge, they still make nutritional mistakes. In our previous work, we studied the level of knowledge of mothers in Poland about children's nutrition and analyzed the food diaries of 363 children [9]. We found that the educational level of mothers was of primary importance, as mothers with less education overestimated their knowledge of nutritional programming. There was a lack of awareness of guidelines for child nutrition. All children consumed too much protein and too little fat, vitamin D, iron and docosahexaenoic acid (DHA). However, we also found promising results. Mothers with adequate nutritional knowledge breastfed longer ($p = 0.041$) and more often ($r = 0.128$, $p = 0.017$, 95% CI: 0.023–0.230). The higher the educational level of the mother, the higher was the DHA intake of the children ($r = 0.294$, $p = 0.006$, 95% CI: 0.477–0.086) [9].

As a continuation of the above study, we attempted to answer the question of whether parents provide their children with dietary supplements to compensate for the deficiencies described above. In addition, we assessed the appropriateness and frequency of supplementation. For this purpose, the parents of 503 children aged up to 3 years were asked to complete an original questionnaire on the frequency, type and reasons for supplementation of their child and to provide their 3-day diet. It was found that up to 79% of all children received dietary supplements; 31% of parents gave vitamin and mineral supplements on the advice of a family member or friend, and 22% because of a decision influenced by marketing and advertising of dietary supplements. The introduction of this unjustified supplementation resulted in very high consumption of B vitamins, vitamin C, vitamin A, and copper among the children studied (%RDA for copper – median {1st–3rd quartile} – 183.40 {115.30–283.14}) [10].

It is also impossible not to mention the widespread obesity among children. This phenomenon is already called an epidemic and is still growing at an alarming rate, affecting younger and younger children. According to experts, 90% of obese children suffer from simple obesity caused by excess calories and simple sugars [11].

Both nutritional deficiencies and excess caloric intake leading to obesity are detrimental to a child's development and health. What is common to both conditions is that they can be effectively prevented because unhealthy eating habits are developed during infancy [12]. Parenting styles, diet and lifestyle, knowledge, and socioeconomic status have profound effects on children's eating behaviors [13, 14, 15, 16, 17, 18]. During the first years of life, parents control children's food intake, reactions to new products, and attitudes toward food [14]. Therefore, it is crucial for parents to acquire adequate nutritional knowledge. Several studies have shown the effectiveness of parental nutritional education in improving the health of their children [19, 20, 21, 22, 23].

Therefore, the aim of this study was to evaluate whether parental nutritional education ensures the proper nutritional status of the child by providing a balanced diet. The research hypothesis is that the nutritional intervention will significantly improve the macro- and micronutrient intake of infants, which will further influence their body weight.

MATERIALS AND METHODS

Study intervention

This study is a continuation of previous research. The participant characteristics, study settings, and inclusion and exclusion criteria were as described previously. Participants were asked to return for follow-up 12 months after completing the study [22]. In previous research, parents were randomly assigned to 1 of 2 subgroups. Parents of 102 infants received intensive mobile nutritional education for about a year. The intervention consisted of intensive nutritional education delivered to parents via short text messages about their infants' feeding (approx. 4–5 times per week). The content of the text messages was tailored to a few conditions (e.g., infant's age, developmental stage, or season of the year). The content of the information was in line with infant feeding standards [24, 25], e.g. advising the mother in which month of life she should give her child the first foods or gluten. This intervention was the longest of similar studies [26, 27]. Text messages were sent on Monday and/or Tuesday morning, Wednesday evening, Friday afternoon, and Saturday morning. The parents of the other 101 infants served as a control group. For the follow-up, 168 participants returned (88 from the intervention group and 80 from the control group). We performed anthropometric measurements and asked the parents to provide a 3-day food diary for their children. The authors of this project verified whether parents in the research group adhered to the dietary recommendations provided by analyzing the children's food diaries as well as the children's anthropometric measurements. Parents also completed a special dietary questionnaire before the study began, during the study and after 1 year to assess the level of parental nutritional education and its practical application in children's nutrition. These results were also analyzed.

Study measurements

The anthropometric parameters (weight, height, body mass index – BMI) of the children were studied. We also analyzed the age of parents, place of residence and level of education. The place of residence was analyzed according to the following criteria: village (from the city agglomeration – in the vicinity of Poznań, a city with less than 500 thousand inhabitants, a city with more than 500 thousand inhabitants), and the educational criteria were as follows: primary (elementary school), secondary (high school), and tertiary (university degree).

Statistical analyses

Statistical calculations were performed as previously described [22]. Infants were weighed on a baby scale without clothing or diapers. The body weight was read with an accuracy of 10 g. The body length was measured in the supine position using a liberometer. The infants had removed their socks, shoes, hats, and hair ornaments. The measurements were read with an accuracy of 1 mm. Each measurement was taken at least twice. The calculated average was used to analyze the results.

According to the formula z = x-mean/SD, the z-score of height and weight was calculated according to the Warsaw Institute of Mother and Child standards [28]. The calculated BMI z-score was interpreted according to the growth standards of the World Health Organization. Body mass index z-score cutoff points of <–2.0, >1.0, >2.0, >3.0 are used to define overweight, at risk of overweight, overweight, and obese [29, 30, 31].

All anthropometric measurements at baseline and at the end of the study were performed by a qualified pediatric nurse.

Ethical considerations

All subjects gave informed consent prior to participation in the study. The research was conducted in accordance with the Declaration of Helsinki [32], and the protocol was approved by the Bioethics Committee of the Medical University of Poznań, Poznań, Poland (Decision No. 723/19).

Dietary intake

Parents provided information about their children's diet over an average of 3 days, including meals, snacks, and fluids. The infants' menus also included information on breastfeeding and formula feeding. Parents were trained by a registered dietitian to complete the food diary. Contact information (e-mail and phone number) for the dietitian was also provided in case of questions.

The children's diets were analyzed using Dietetyk 2015 (Jumar Software, Poznań, Poland). The NutritionData.com database was used for the study. According to Polish nutritional standards, the average daily intake of macronutrients in children was calculated and compared with the recommended dietary allowance (RDA) [33]. The use of dietary supplements was taken into account in the analysis of the diets.

RESULTS

Most of the respondents lived in the village (61%) and had a university degree (77%). The mean age did not differ between the groups studied and was 30 years, most parents in both groups had tertiary education (GR 1 – 75% and GR 2 – 77%).

Table 1 shows the birth weight of the children at the beginning and at the end of the study. The difference in the mean z-score for BMI between the groups was 0.991. At baseline, the groups did not differ in birth weight, z-score for birth weight, and z-score for BMI. However, at the end of the study, the intervention group had significantly lower weight and BMI compared to the control group. As shown in Table 1, the mean weight in the control group after 12 months was close to being overweight (0.927) and the third quartile of this parameter as 1.450. This means that being overweight is popular in the control study, while the values in the intervention group were in the normal weight range.

TABLE 1. Body weight in infants

Parameters	GR 1 (n = 88)	GR 2 (n = 80)	p
	Median (1st–3rd quartile)		
Birth weight (g)[1]	3430 (3285–3570)	3476 (3172–3785)	NS
Z-score for birth weight[1]	0.664 (0.261–1.087)	0.865 (0.035–1.402)	NS
Z-score for BMI[1]	0.756 (0.304–1.018)	0.832 (0.027–1.319)	NS
ΔWeight after 12 months (g)[1]	6235 (5605–6550)	7665 (6360–8350)	<0.001
	Mean (1st–3rd quartile; SD)		
Weight after 12 months (g)[2]	9550 (9330–10255; 0.545)	112250 (10135–12010; 1.238)	<0.001
Z-score for weight after 12 months[2]	-0.133 (-0.339 – -0.043; 0.279)	0.927 (0.145–1.450; 1.001)	0.004
Z-score for BMI after 12 months[2]	-0.173 (-0.358 – -0.048; 0.215)	0.818 (0.124–1.424; 0.936)	<0.001

GR 1 – intervention group; GR 2 – control group; NS – not significant; BMI – body mass index; SD – standard deviation
[1] Mann–Whitney test; [2] Student's t-test

Finally, dietary composition and macronutrient content were estimated. After 1 year of dietary education, children in the control group had statistically higher intakes of energy, fats, carbohydrates, and sucrose and lower intakes of fiber [22]. The effect was still evident after 12 months (Tab. 2). In addition, the diets of children in the control group were still less varied than those of their peers in the intervention group, with significant amounts of sweets, processed foods, and ready-to-eat infant formula. Infants in the intervention group ate more vegetables and fruits, had several sources of complex carbohydrates (cereals, pasta, rice) and complete protein in the form of lean meat and dairy products in their diets. The significant difference in dietary intake between the groups was seen for almost every nutrient studied.

TABLE 2. Dietary intake in children

Dietary intake (%RDA)	GR 1 (n = 88)	GR 2 (n = 80)	p
	Median (1st–3rd quartile)		
Energy*	107.53 (102.55–110.86)	134.56 (123.98–145.15)	<0.001
Proteins*	311.05 (280.34–332.02)	302.93 (260.67–400.68)	NS
Fats*	90.56 (87.34–108.08)	108.72 (93.58–130.92)	<0.001
Carbohydrates*	101.05 (95.97–108.41)	123.79 (113.02–140.46)	0.029
Saccharose*	9.45 (8.62–11.60)	13.96 (5.43–17.25)	<0.001
Fiber*	133.50 (104.16–181.45)	83.50 (65.87–100.82)	<0.001
Potassium*	100.82 (67.42–106.23)	55.54 (44.22–73.92)	<0.001
Sodium*	94.07 (79.62–103.22)	50.09 (44.55–74.84)	<0.001
Calcium*	86.01 (79.78–104.61)	78.82 (68.97–112.09)	0.011
Phosphorus*	155.29 (152.13–174.93)	117.27 (94.61–150.30)	<0.001
Magnesium*	233.96 (166.35–266.34)	142.25 (118.00–163.44)	<0.001
Iron*	102.58 (86.38–121.56)	63.20 (44.77–104.89)	<0.001
Zinc*	160.78 (130.38–213.13)	91.73 (65.13–137.58)	<0.001
Copper*	264.16 (166.62–316.57)	125.33 (76.00–197.00)	<0.001
Vitamin A*	226.71 (103.88–295.82)	146.92 (125.40–226.43)	<0.001
Vitamin D*	28.11 (14.49–101.00)	23.61 (20.48–113.00)	NS
Vitamin E*	113.10 (100.93–134.42)	94.99 (56.67–121.23)	<0.001
Vitamin C*	255.80 (158.25–410.10)	182.56 (115.60–207.50)	<0.001
Vitamin B1*	153.81 (135.63–161.84)	134.96 (81.85–116.73)	0.001
Vitamin B2*	196.17 (175.91–262.90)	233.18 (146.45–245.81)	0.013
Niacin*	158.81 (76.18–208.95)	106.29 (71.49–167.19)	0.015
Vitamin B6*	235.50 (141.76–321.76)	141.10 (129.70–212.00)	<0.001
Vitamin B12*	156.61 (131.41–276.89)	216.00 (126.22–271.11)	NS
Folate*	159.08 (93.93–185.55)	72.02 (63.35–93.10)	<0.001

RDA – recommended dietary allowance according to Polish nutritional standards [33]; GR 1 – intervention group; GR 2 – control group; NS – not significant
* Mann–Whitney test

DISCUSSION

The aim of this study was to answer the question of whether the nutritional education of parents translates into ensuring the good nutritional status of the child. Comparing both anthropometric data and analyses of macronutrient and micronutrient content in the diets of children from both groups after the intervention, it must be said that the nutritional education of parents had a huge impact on the nutritional status of the child. The parental nutritional intervention resulted in statistically significant higher values of red blood cells (RBC; p = 0.020), hemoglobin (HGB; p = 0.039), hematocrit (HCT; p = 0.036), mean cell volume (MCV; p = 0.018) parameters and dietary iron intake (p ≤ 0.001) [22]. In addition, the intervention group showed statistically significant lower levels of triglycerides (TG), triglyceride/high-density lipoprotein (TG/HDL) ratio parameters and higher concentration of albumins. The control group was characterized by a higher number of children with excessively high TG levels and TG/HDL ratio values, while HDL levels were inadequate [23].

To the best of our knowledge, this project is the first to evaluate the effect of parental education on children's anthropometric-metabolic parameters at such an early age. Several studies have shown the positive effects of parental nutritional education on children's nutritional status [19, 20, 21]. However, our study is the first in Central and Eastern Europe to start the education of children at this early age and to involve both parents in a very simple and inexpensive way using modern technology.

The Identification and Prevention of Dietary- and Lifestyle--induced Health Effects in Children and Infants (IDEFICS) study investigated the relationship between parental education level and the frequency of consumption of obesity-related foods in European children. Parental education level had a strong effect on children's consumption of these foods. Children in the low and medium parental education groups had significantly lower odds of more frequent consumption of low-sugar and low-fat foods (i.e. vegetables, pasta/noodles/rice and whole-grain bread, fruit) and higher odds of more frequent consumption of high-sugar and high-fat foods (fried potatoes, snacks/desserts and sugary drinks, fruit with sugar, and nuts). Low parental education was associated with children's consumption of sugary and fatty foods. High parental education was associated with intake of low-sugar and low-fat foods [34]. We find similarities in our study with regard to parental nutritional education. Children in the control group had statistically higher intakes of energy, fats, carbohydrates, and sugars, and lower intakes of fiber. Their diets were less varied than those of their peers in the intervention group, with significant amounts of sweets, processed foods, and infant formulas. Infants in the intervention group ate more fruits and vegetables, had multiple sources of complex carbohydrates (cereals, pasta, rice), and had complete protein in the form of lean meat and dairy products in their diets.

In addition, a recent study in Norway showed that children of low-educated parents gained more excess weight at 2 years than children of high-educated parents (total effect, RRTE = 1.06; 95% CI: 1.01–1.10). In addition, children of low-educated parents were more likely to be overweight or obese than children of high-educated parents [20]. Our study showed that children in the study group consumed significantly less energy than children in the control group. Parental nutritional education was a protective factor against childhood obesity.

Parental perceptions of children's healthy eating habits are also important. Hendaus et al. demonstrated that even when children (n = 151; 37%) fell into the overweight and obese categories, only 17% of parents perceived this. Most participants (n = 324; 81%) agreed that parental dietary habits can influence childhood weight and that a healthy diet leads to better school performance (n = 372; 94%) and better quality of physical activity (n = 379; 96%) [35]. However, this study was conducted in Qatar, where the socioeconomic status of parents tends to be high. Parents with low socioeconomic status may struggle to provide a good lifestyle and nutritional environment.

McManus et al. conducted a formative evaluation with key health informants and parents to understand the specific strategies families use at mealtimes to promote family health and the barriers they face in participating in current nutritional education programs. Respondents identified stress reduction, health literacy, and cooking skills as areas of interest [36]. Not only are guidelines for children's nutrition of primary importance, but acquiring the skills to apply them in practice is also necessary. In our research, parents were given practical advice on how to prepare food for their children in addition to the various receipts. Acquiring the skills to adequately prepare food for their children may be one of the larger factors influencing child nutrition in our study.

Another factor may be parental feeding practices. Flores-Barrantes et al. studied parental behavior and feeding practices in 6 European countries. Parental education was associated with children's higher intake of water, fruits and vegetables, and lower intake of sugary foods and salty snacks. The authors concluded that parental food practices explained the associations between parental education and dietary intake in almost all cases. For example, home availability of soft drinks explained 59.3% of the association between parental education and intake of sugary foods. Home availability of fruits (77.3%) and vegetables (51.5%) was the strongest factor in the association between parental education and consumption of these products. Home availability of salty snacks and soft drinks was the strongest mediator of children's consumption (27.6% and 20.8%, respectively) [37]. This study only adds to the evidence that parents are the most powerful influence on their children's behavior. Our study provided parents with extensive knowledge about children's satiety and hunger cues and how to respond appropriately to their behavior. The responsibility of making healthy choices and the impact of those choices on their children's health was also emphasized. We believe that this translated into the ability to make healthier choices for their children's health, which was evident in the comparison of dietary intake between the control and study groups.

In the Special Turku Coronary Risk Factor Intervention Project for Children (STRIP), Räsänen et al. investigated how 6.5 years of a child-focused nutritional intervention affected the knowledge, attitudes, and dietary habits of the parent who was mainly responsible for buying and preparing food. Parents who experienced the intervention through their children had better knowledge than control parents about the causal relationship between food choices and coronary heart disease and about the nutritional composition of foods. The quality of fat in their diets was better and they consumed less salt [38].

A child-focused nutritional intervention increased parental nutritional knowledge and improved parental diet quality. However, parents' nutritional knowledge was poorly correlated with their nutrient intake. Providing education to parents appears to have a greater impact on their ability to improve their children's and possibly their own diet.

In their study, Romanos-Nanclares et al. demonstrated that parental nutritional knowledge and healthy eating attitude scores were independently associated with children's micronutrient intake and children's diet quality. However, they pointed out that public health strategies should focus on promoting parental healthy-eating attitudes rather than simply educating parents about what to feed their children [39]. The importance of the influence of parental behavior on children's practices is paramount. This was also reflected in our study, as despite the provision of guidelines to parents, children in the study group still consumed too much protein. Therefore, parents need to be educated on how to provide appropriate meal portions and plate composition appropriate for their child's age.

Clark et al. focused on parents' use of different child feeding behaviors, including monitoring, pressure to eat, and restriction. It is worth noting that parental restriction of children's food intake was associated with weight gain in children. Parents may inadvertently promote excessive childhood weight gain through inappropriate child feeding behaviors [40]. Although in our study we provided parents with knowledge about appropriate feeding behaviors, special attention should be given to families struggling with overweight and obesity in this regard.

It is worth noting that most studies have been conducted in children who are already overweight or obese [19]. Thus, intervention focuses primarily on weight loss and lifestyle changes. Our study was based on prevention. However, there are still areas of parental nutritional education that need to be addressed. For example, the importance of providing children with adequate vitamin D intake and supplementation, or limiting the consumption of meat and other high-protein foods. Although the long-term consequences of excessive protein intake are unclear, it is emphasized that high protein intake has hormonal effects (changes in the insulin-like growth factor 1 axis) and may contribute to an increase in BMI. However, high urea levels may exceed the capacity of the liver and kidneys to metabolize and excrete excess nitrogen [41, 42, 43].

The limitations of the study and implications for further research

Recruitment of parents of infants in pediatric outpatient clinics influenced the diversity of the group in terms of place of residence and level of education. Higher levels of education may result in higher levels of nutritional education at baseline. The authors analyzed the results between the groups and found no statistically significant differences. This was true before the study, immediately after the intervention ended, and 1 year after the intervention ended. However, despite the level of education, parents still made feeding mistakes. Therefore, they still need appropriate guidance and counseling in this regard.

It is important to note that the dietary interview was conducted 12 months after the end of the intervention. The results of this interview may depend on various factors such as the age of the child, the season, and the availability of fresh produce. This is a limitation for a clear interpretation of the study results.

The basis for further research should be to enroll parents from different regions across the country. In addition, the income level and socioeconomic status of the parents should be considered to understand the target population. In addition, it is worth evaluating (after 5–10 years) whether or not early nutritional education contributes to beneficial nutritional status in later life.

CONCLUSIONS

Our study showed that parental nutritional education influenced, among other things, BMI z-score (the difference between the groups was 0.991) and macro- and micronutrient intake in children. This influence was still visible 12 months after the end of the study. The final results of our study showed that proper nutritional education can improve the nutritional status of children at the population level. Parental knowledge of the principles of child nutrition can promote proper child development by protecting against metabolic disorders and their consequences in the future. Therefore, it is crucial to cover nutritional interventions for parents on a broader scale.

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