Effect of Nutrition Education through Pegia e-Health on Mothers' Knowledge, Attitudes, Practices and Their Impact on Nutritional Intake of Children Aged 3-6 years

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ABSTRACT

Background: Mothers' nutritional knowledge, attitudes, and practices influence children's feeding habits. Therefore, mothers are expected to receive appropriate nutrition education to improve dietary behaviors. This research aimed to analyze the influence of nutrition education through Pegia e-Health on mothers' nutritional knowledge, attitudes, and practices, as well as its impact on the nutritional intake of children aged 3-6 years. **Method**: The design used a quasi-experimental pretest-posttest group. This research was conducted for 12 weeks, and the total number of respondents was 54 mothers with children aged 3-6 years from 8 preschool institutions in Banyumas Regency. **Results**: There was a significant increase in median knowledge, attitudes, and nutrition practice scores by 8.0, 5, and 1.0 points (p: 0.000 <0.05). Furthermore, there was a significant increase in nutritional intake, including 31.15 g of carbohydrates, 1.44 g of fiber, and 380.07 RE (Retinol Equivalents) of vitamin A (p <0.05). **Conclusion**: Pegia e-Health had an impact on improving mothers' knowledge, attitudes, and practices, as well as the increase in carbohydrate, fiber, and vitamin A intake in children. It was recommended that mothers increase the frequency and access time to Pegia e-Health to improve their dietary behaviors.

1. Introduction

Global data shows around 38% of toddlers and preschool children are experiencing feeding problems[1]. Davinson et al.[2] found that the nutritional density of food in preschool children was low, with most of the intake coming from snacks, insufficient energy, and protein density can affect their nutritional status. The lower the energy and protein intake density, the poorer the nutritional status. Vegetable and fruit consumption in preschool children is also a concern. A Indonesia Total Dietary Survey found that only 48% aged 0-59 months consume leafy vegetables, while the percentage increases to 66.6% for children aged 5-12 years[3].

According to Mustikawati [4] children have similar dietary behavior with their parents. Children growing up in families with lazy or selective eating habits tend to adopt the same behavior. According to Scaglioni [5] parents' eating habits influence the formation of children's eating patterns. Furthermore, parents are responsible for providing food for their children. Therefore, in order to provide good food intake to children, a mother must have good knowledge. Purnamasari[6] stated that mothers' knowledge about balanced nutrition was low, and this affected the quality of food provision at home, as well as the children's nutritional status.

Currently, nutrition education using technology is an alternative. There are various types of technology-based nutrition education such as electronic health records, telemedicine and e-Health[7]. According to Barnett[8] the use of e-health technology offers innovative opportunities to strengthen community-based growth monitoring and make it more effective in addressing malnutrition in children. Bensley[9] compared nutrition intervention through technology-based education with conventional methods. The results showed that education through technology was more easily accepted and improved children's nutritional intake compared to conventional interventions. Referring to the explanations, this research aims to analyze the effectiveness of nutrition education using the e-Health application on mothers' behavior and its impact on children's nutritional intake.

2. Methods

2.1. Study design

This quasi-experimental research with a pretest-posttest group was conducted for 12 weeks, from September to December, 2022.

2.2. Location

It was conducted in 8 preschool institutions located in 4 sub-districts (North, South, West, and East Purwokerto) in Banyumas Regency, Indonesia.

2.3. Population and Samples

Population were mothers with children aged 3-6 years in Banyumas Regency. A total of 54 participants were selected through purposive sampling and the inclusion criteria were mothers with children aged 3-6 years attending the 8 selected preschool clusters. Additionally, participants had to own and be able to operate a smartphone. This is important because the intervention using e-Health application must be accessed using a smartphone.They also needed to be willing to sign the research informed consent form.

2.4 Material and Instrument

The instrument was Pegia e-Health. This application was developed by researchers themselves with the help of professional application developers. Currently this application is an open application and uploaded to the Playstore.

Meanwhile, Pegia e-Health consisted of 7 display menus, including checking the children's nutritional status, nutrition posters, balanced nutrition guidelines, children's nutritional needs, healthy menu for children, children data, and information about the application. The following figure 1 are the display menus found in Pegia e-Health.
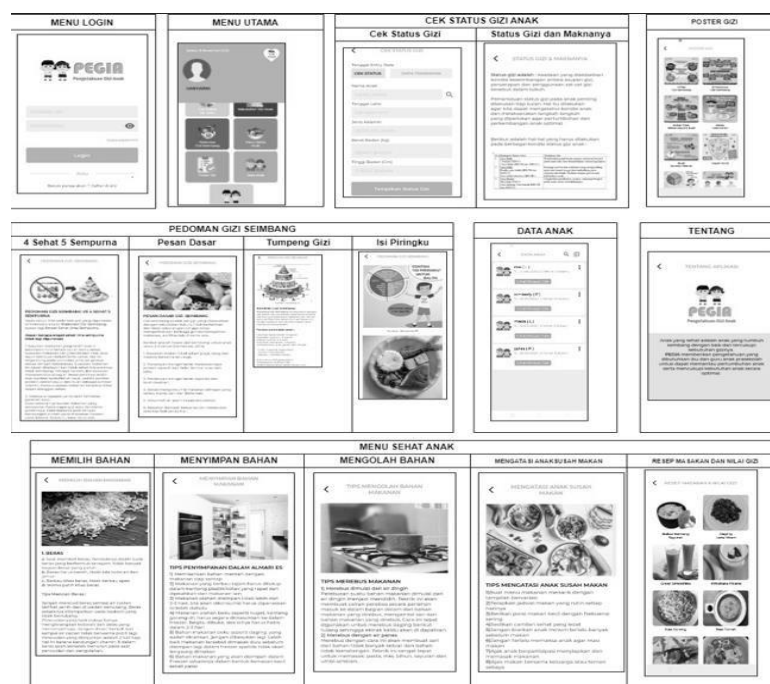
Figure 1. Display Menus of Pegia e-Health

A structured questionnaire was used to measure mothers' knowledge, attitudes and practices. Recalling children's food consumption by 24 hour recall. Baseline consumption recall data was taken 2x, while endline 2x, then each result was averaged.

2.5. Research Stages

The research was conducted for 12 weeks. The meetings were held four times The first meetings were held at the beginning of the first week, informed consent forms were filled out, baseline data were collected, and Pegia e-Health was installed. The second meeting was held at the beginning of the fifth week and the third meeting at the beginning of the eighth week.In the second and third meeting, education sessions were carried out based on the materials available. The educational session was held for two hours. In the fourth meeting (end of the twelfth week) endline data were also collected. Respondents were required to access and study the application. Frequency and time of access data were also collected.

2.6. Data Analysis

Food consumption was analyzed using Nutri survey software. Data analysis was performed using MS Excel and SPSS version 21, while the data distribution was tested using the Kolmogorov-Smirnov test. The paired sample t test was used to analyze the differences before and after the intervention since most of the data distributions were normal (knowledge, practices, energy, protein, fiber, iron and vit a) , and the Wilcoxon test was used of the data distributions were not normal (attitude dan fat). The significance level was set at $p < 0.05$.

3. Results and Discussion
Respondent Characteristics

The majority of mothers were between the ages of 31-40 years (63%), with the highest level of education being high school graduates (44.4%), and housewives (72.2%). A total of 59.7% of respondents were classified as living near the poverty line. About 68.5% had received nutrition-related materials, with 43.9% accessing the Internet.

Table 1 Distribution of mothers based on characteristics

	Mothers (n=54)	
Variable	n	%
Age (years)		
20-30	15	27.7
31-40	34	63.0
41-50	4	7.4
51-60	1	1.9
Education		
Senior High Schol	24	44.5
Diploma III	10	18.5
Bachelor Degree	20	37.0
Access to nutritional info		
No	17	31.4
Yes	37	68.5
Information Source		
Nutrition Cadres/officers	5	15.5
Internet	17	45.9
Television	12	32.4
Preschool teacher	3	8.1
Number of families (people)		
3-4	45	83.3
5-7	9	16.7
Occupation		
Housewife	39	72.2
Private sector employee	10	18.5
Civil servant	5	9.3
Income (IDR/capita/month)		
≤ 441520	29	59.7
> 441520	25	46.3

Table 2 Distribution of mothers based on correct knowledge answers

No	Question	Mothers (n = 54)		
		Baseline n (%)	Endline n (%)	Differences n (%)
1	What to do to overcome malnutrition in children?	52 (96.3)	53 (98.1)	1 (1.8)
2	Why is 4 healthy 5 perfect irrelevant?	32 (59.3)	49 (90.7)	17 (31.4)
3	What is the principle of balanced nutrition?	22 (40.7)	40 (74.1)	18 (33.4)
4	How many servings of carbohydrates are recommended in a day?	10 (18.5)	48 (88.9)	38 (70.4)
5	How many servings of vegetables are recommended in a day?	13 (24.1)	43 (79.6)	20 (55.5)
6	How many servings of protein are recommended in a day?	12 (22.2)	38 (70.4)	26 (48.2)
7	What is the recommended limit for salt in a day?	33 (61.1)	52 (96.2)	19 (35.1)
8	How much is the recommended limit for sugar in a day?	33 (61.1)	51 (94.4)	18 (33.3)
9	How much is the recommended limit for oil in a day?	13 (24.1)	46 (85.2)	33 (61.1)
10	What percentage is the recommended proportion of rice in one plate?	23 (42.6)	52 (96.3)	29 (53.7)
11	What percentage is the recommended proportion of vegetables in one plate?	23 (42.6)	45 (85.2)	22 (42.6)

No	Question	Mothers (n = 54)		
		Baseline n (%)	Endline n (%)	Differences n (%)
12	What percentage is the recommended proportion of side dishes in one plate?	18 (33.3)	46 (85.2)	28 (51.9)
13	Why do you have to eat fruit and vegetables in sufficient quantities?	43 (79.6)	53 (98.1)	10 (18.5)
14	How do deal with children who are difficult to eat vegetables?	51 (94.4)	54 (100)	3 (5.6)
15	What are the benefits of physical activity in children?	44 (81.5)	50 (92.6)	14 (11.1)
	%Average increase value			36.9

Table 2 shows an increase in correct knowledge answers, with the highest and smallest observed in questions 4 and 1 regarding the recommended carbohydrate portions per day and what should be performed to address malnutrition in children, with a knowledge increase of 70.4% and 1.8%, respectively.

Table 3 Distribution of mothers based on positive attitudes

No	Question	Mothers (n = 54)		
		Baseline n *(%)*	*Endline* n (%)	Differences n (%)
1	Balanced nutrition is important for children's health.	48 (88.9)	48 (88.9)	0 (0.0)
2	Weighing and knowing the nutritional status of children should be performed every month.	43 (79.6)	43 (79.6)	0 (0.0)
3	Implementing portions according to the contents of my plate is important for children.	18 (33.3)	37 (68.5)	19 (35.2)
4	In my opinion, the portion of carbohydrates for children is enough 2 servings a day.	2 (3.7)	25 (46.3)	23 (42.6)
5	In my opinion, the serving of side dishes for children is 2-4 servings a day.	18 (33.3)	27 (50)	9 (16.7)
6	I think the portion of vegetables for children is enough 1-2 servings a day.	2 (3.7)	29 (57.3)	27 (53.6)
7	I think children should drink 6-8 glasses a day.	23 (42.6)	36 (66.7)	13 (24.1)
8	In my opinion, children can consume a maximum of 7 tablespoons of sugar a day.	3 (5.6)	18 (33.3)	15 (27.7)
9	In my opinion, children should limit salt consumption to a maximum of 1 teaspoon a day.	12 (22.2)	27 (50)	15 (27.8)
10	In my opinion, good physical activity is once per week.	2 (3.7)	21 (38.9)	19 (35.2)
	%Average increase value			26.29

Table 3 showed proportion of positive mothers' attitudes increase 26.29%, with the highest observed in statement number 6 regarding the recommended vegetable portions at an increase of 50%. However, there was no increase in the understanding of the importance of balanced nutrition (statement number 1) and knowledge of the children's nutritional status (statement number 2).

Table 4 Distribution of mothers based on positive practices

No	Question	Mothers (n = 54) Baseline n (%)	Endline n (%)	Differences n (%)
1	I have given a source of carbohydrates 3-4 servings a day	49 (90.7)	54 (100)	5 (9.3)
2	I have provided a source of protein for children 2-4 servings a day	53 (98.1)	53 (98.1)	0 (0.0)
3	I have given vegetable sources to children 3-4 servings a day	30 (55.6)	50 (92.8)	20 (37.2)
4	I have given fruit sources to children 2-3 servings a day	36 (66.7)	52 (96.3)	16 (29.6)
5	I have given water to children 6-8 glasses a day	47 (87)	52 (96.3)	5 (9.3)
6	I have given food according to the portion of the contents of my plate to the children	27 (50.3)	34 (59.3)	7 (9.0)
7	(picture of my plate)	46 (85.2)	54 (100)	8 (14.8)
8	I have limited sugar for children up to 4 tablespoons a day	33 (61.1)	41 (75.9)	8 (14.8)
9	I have limited oil for children, a maximum of 5 tablespoons a day	45 (83.3)	52 (96.3)	7 (13.0)
10	I have invited children to do activities at least 3 times per week	42 (77.8)	54 (100)	12 (22.2)
	%Average increase value			15.92

Table 4 showed the highest increase in positive practices observed in practice number 3, which was giving vegetables to children at 3-4 servings per day, with an increase of 37.2%. However, there was no increase in the practice of giving main dishes at 2-4 servings per day (practice number 2).

Table 5 Distribution of changes in mothers' behavior

Variable	Baseline	Endline	Differences	p
Knowledge				
Median	21.0	29.0	8.0	
Min	11.0	12.0	1.0	
Max	28.0	30.0	2.0	0.000**
IR	6.2	3.0	3.2	
Attitude				
Mean	36.0	41.0	5.0	
Min	29.0	31.0	2.0	
Max	44.0	50.0	6.0	0.000**
SD	2.6	4.8		
Practice				
Median	18.0	19.0	1.0	
Min	12.0	16.0	4.0	
Max	20.0	20.0	0.0	0.000**
IR	2.25	1.0	1.25	

SD:Standard Deviation, IR:*Interquartile Range, wilcoxon test, paired sample test, **p<0,05*

At baseline, the knowledge of mothers regarding balanced nutritional portion guidelines for children is still lacking. research conducted by Purnamasari et al shows that mothers' knowledge of balanced nutrition is insufficient [6] e-Health also contains information about balanced nutrition guidelines, including portion sizes. Therefore, there is an improvement in mothers' knowledge of balanced nutrition after the intervention. Regarding attitude, a positive attitude should be reflected in disagreeing with the statement, According to the balanced nutrition guidelines, the recommended portion of vegetables is 3-4 servings[10]. This is supported by the increase in the practice of giving vegetables to children, which increased by 37.2%. Consumption of vegetables and fruits among preschool children remains a problem. The Total Diet Survey in Indonesia also states that only 48% of children aged 0-59 months consume vegetables[3]. In Pegia e-Health, there is information about

vegetable portions according to the balanced nutrition guidelines, as well as strategies to deal with the reluctance to eat vegetables. This information can improve mothers' practices in providing vegetables to their children. In terms of knowledge, there was a significant increase in the median knowledge, practice, and average scores by 8.0 (p-value: 0.000), 1.0 (p-value: 0.000, and 5 points (p-value: 0.000), respectively.

In the mothers' behavior scores, there is also an improvement before and after the intervention. These results are consistent with Amaliah[11] using the mobile application *"Balita Sehat"* (Healthy Toddler). After a 3-month intervention, there is an increase in knowledge and attitudes scores among mothers regarding child care. In the research by Chen [12] using the online sugar fact application for mothers with a duration of 9 months, there is an increase in knowledge, attitude, and practice scores regarding sugar recommendations and labeling by 2, 0.2, and 0.8 points. Nazilia[13] showed an improvement in the category of good knowledge among mothers by 61.2% after the intervention with the *"Anak Sehat Makan Sehat (Emas)"* (Healthy Child, Healthy Eating). Factor influencing mothers' feeding practices is the knowledge of children's nutrition[14], [15]. A high level of mothers' nutrition knowledge leads to a positive attitude towards nutrition issues. Furthermore, knowledge does not have a positive impact when mothers lack attitude toward providing proper meals for their children[16] attitudes enable practices in providing sufficient daily food. Kajjura[17] found that good mothers' knowledge can increase meal frequency, food diversity, and preparation quality. Mothers' behavior can also affect the availability, influencing children's food intake. In addition, parents have an influence on shaping consumption patterns because children imitate them.

Several factors contribute to preschool mothers' willingness to change their behavior after e-Health intervention. According to Contento[18], behavior change should occur voluntarily and based on self-awareness. Nutrition education should be voluntary, recognizing and respecting that individuals have the freedom to make choices based on goals or values. Research by Kim[19] on Need Assesement of nutrition education showed that success is driven by the interest in the provided intervention and 58.6% of preschool parents reported interest in the concept. Furthermore, the desired topics included food labeling and preparation methods. Referring to Cornwal[20] parents' increased understanding and practice of nutrition after receiving nutrition education occurs because they realize that these changes have positive impacts on children's health. A systematic review conducted by Zarnowiecki[21]on 9 e-Health applications showed that parents desired credible information and engaging platforms for effective e-Health interventions. In the Pegia research, informed consent was obtained before starting the intervention, ensuring the voluntary aspect as participants willingly joined the research without coercion. The research was also subjected to validation by nutrition experts, confirming the validity of the information in Pegia e-Health. The developed platform has been designed to meet user preferences, including colors, fonts, appealing visuals, and content aligned with applicable balanced nutrition guidelines.

The analysis indicated a significant increase (p < 0.05) in nutritional intake for carbohydrates fiber, and vitamins by 31.5 g, 1.44 g, and 380.07 RE. The increased nutrient intake (p > 0.05) included energy, protein, and fat of 103.09 kcal, 1.39 g, and 3.58 g. Furthermore, there was a non-significant decrease of 0.67 in iron intake. The increase in carbohydrate intake is due to a greater variety of carbohydrate sources, not only rice but also bread and noodles. In this study, there was an increase in fiber and Vitamin A intake, as there was a rise in the consumption of vegetables and fruits such as spinach, kale, papaya, and watermelon. This could happen because the e-Health Pegia application provided education on food diversity and good sources of vegetables and fruits for health. As for iron and protein, there was no increase because the respondents did not consume many iron-rich foods. The most commonly consumed protein was plant-based, such as tofu and tempeh, while animal-based protein sources were rarely consumed. Taylor[22]showed that e-health intervention for mothers can increase vegetable consumption and fiber intake in children. A systematic review by Wolfenden [23] analyzed different interventions to improve vegetable and fruit consumption in children. e-Health interventions were found to be effective in the short term (12 weeks) and increased vegetable and fruit consumption in children. According to Haszard[24], children who are guided to eat healthily will consume more vegetables and fruits while reducing the consumption of sweet foods.

Table 6 Distribution of changes in children's nutritional intake

Variable	*Baseline*	*Endline*	Differences	*P*
Energy (kkal)				
Mean	1217.32	1320.41	103.08	0.050
Min	622.90	766.70		
Max	2863.00	1651.40		
SD	364.52	193.99		
Mean % EA	96.78	114.02	17.24	
Protein (g)				
Mean	43.68	45.04	1.36	0.516
Min	82.30	26.50		
Max	82.30	74.00		
SD	13.47	10.00		
Mean %PA	206.24	205.87	-0.37	
Fat (g)				
Median	44.92	48.5	3.58	0.925
Min	18.50	21.30		
Max	150.10	89.80		
SD	17.15	20.65		
Median %FA	99.0	107.0	8.0	
Carbohydrate				
Mean	152.03	183.18	31.15	0.000**
Min	74.60	105.90		
Max	295.30	233.10		
SD	49.48	27.83		
Mean %CA	74.81	95.39	20.58	
Fiber				0.023*
Mean	6.37	7.81	1.44	
Min	1.00	3.10		
Max	18.79	13.00		
SD	3.83	2.67		
Mean %FA	37.80	43.63	5.83	
Iron (mg)				0.148
Mean	5.54	4.87	0.67	
Min	1.60	2.30		
Max	25.90	8.70		
SD	3.79	1.49		
Mean %FeA	58.55	51.10	7.45	
Vit A (RE)				0.001**
Mean	802.14	1182.48	380.34	
Min	141.0	9.80		
Max	2933.94	3805.4		
SD	469.91	586.55		
Mean %VA	178.70	254.01	75.31	

Paired sample test ˙ Wilcoxon test, significant p<0,05. EA: Energy Adequacy, PA: Protein Adequacy, FA:Fat Adequacy, CA:Carbohydrate Adequacy, FA:Fiber Adequacy, FeA:Fe Adequacy VA:Vit A Adequacy

Table 7 Distribution of mothers based on frequency and time of Pegia e-Health access

Variable	Baseline	Endline	Difference	p-value
Frequency/week				0.000**
Median	1	2	1	
Min	1	1	0	
Max	4	6	2	
IR	1	2	1	
Access time (minutes)				0.025*
Median	5	10	5	
Min	5	5	0	
Max	45	60	15	
IR	10	10	0	

IR:interquartile range Wilcoxon test significant $p<0.05$

There was a significant increase in accessing once a week (p-value: 0.000) and 5 minutes per access (p-value:0.025). Breitenstein[25] examined compliance in using the mobile health app ezParent, which was a parental app about children's health, and lasted for 3 months. Compliance was measured by indicators of frequency, duration, and activity. On average, parents accessed the app 13.6 times in 3 months, with an average duration of 14 minutes per access, and 82% completed the module materials available in the app. In Amaliah's research[11], the frequency of app access was divided into two categories, namely low and high when accessed less and more than 10 times in the 3-month intervention period, respectively. The results showed that mothers with low app utilization had a 2.69 and 1.65 times higher risk of not experiencing knowledge improvement and not improving their nutritional attitudes compared to those with a high frequency of app usage. In the Pegia e-Health research, the majority of participants had a total endline frequency of 12-24 accesses (1-2 times per week) during the 3-month intervention, indicating a good frequency of app usage. According to Short[26] factors influencing app usage compliance include interest, attention, and intervention usage. Interest referred to individuals' interest in a specific topic stimulated by new information. Attention was the conscious focus on information, while usage encompassed the extent interventions were utilized by users. The duration of app access in the Pegia e-Health research at the endline was 10 minutes, showing an increase compared to the previous duration of only 5 minutes. This showed an improvement in interest, attention, and intervention usage perceived by Pegia e-Health users. The limitation of this study is that there is no control with different media, so that the effectiveness of the e-health application pegia can not be compared with other media. Further research can add control in research with different technology media such as using websites or social media.

4. Conclusion

In conclusion, Pegia e-Health was impactful in improving mothers' knowledge, attitudes, and practices, while also increasing children's intake of carbohydrates, fiber, and vitamin A. As a recommendation, mothers should increase the frequency and duration of accessing Pegia e-Health to further improve nutritional behaviors.

5. Acknowledgement

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