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Effect of Moringa leaf supplements during pregnancy: Follow-up study on the development of pre-school children in rural area, Indonesia

Efecto de los suplementos con hoja de moringa durante el embarazo: estudio de seguimiento sobre el desarrollo de niños en preescolar en área rural, Indonesia

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SUMMARY

Moringa leaves (ML) have been proven as a nutrient supplement during pregnancy. This is a study of a follow-up study of experimental research that provided Moringa supplements in the form of flour (GTK) and extract (GEK) as well as iron folate supplements (GBF) to pregnant women. Micronutrients are very important for the development of the child's brain in the uterus and infancy. This study aimed to assess the extent of the effect of Moringa leaf supplementation on pregnant women on the development of children at preschool age (5-6 years) in Jeneponto Regency. This study is an analytical observational study with a cross-sectional design with a total sample of 301 preschool-age children (5-6 years) taken by purposive sampling in six sub-districts in Jeneponto Regency whose pregnant mothers received moringa leaf and iron folate supplements. Measurement of child development was performed using the Pre-Developmental Screening Questionnaire. Data analysis was done using the SPSS 25 program and statistical analysis with the Kruskal-Wallis test, stratification, and Chi-Square. The sample consisted of 155 boys and 146 girls, with an economic status of 90.36 % lower middle class and 86.7 % of mothers as Income Reporting Threshold (IRT). The results showed that there was no developmental difference between the children whose pregnant mothers were treated with GTK, GBF, and GEK (p=0.294). However, the average score of

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preschool children in the Moringa group (GEK) showed better development. After control, the results of the stratification test showed that there were differences in the development of preschool children based on Early Childhood Education and Development (ECED) participation in the "no" category in the three groups (p = 0.022). Giving Moringa leaf supplements during pregnancy can be an alternative to blood tablets, besides the need for parental attention in maximizing child development through exclusive breastfeeding continued for up to 2 years, stimulation of early development, and children's participation in ECED classes.

Keywords: *Pregnant women, moringa leaves, preschool child development.*

RESUMEN

Las hojas de moringa (ML) han demostrado ser un suplemento nutricional durante el embarazo. Este es un estudio de seguimiento de una investigación experimental que proporcionó suplementos de Moringa en forma de harina (GTK) y extracto (GEK), así como suplementos de folato de hierro (GBF) para mujeres embarazadas. Los micronutrientes son muy importantes para el desarrollo del cerebro del niño en el útero y la infancia. Este estudio tiene como objetivo evaluar el alcance del efecto de la suplementación con hojas de Moringa a mujeres embarazadas en el desarrollo de niños en edad preescolar (5-6 años) en Jeneponto Regency. Es un estudio observacional analítico con un diseño transversal con una muestra total de 301 niños en edad preescolar (5-6 años) tomados por muestreo intencional en seis subdistritos en Jeneponto Regency cuyas madres embarazadas recibieron hoja de moringa y folato de hierro. suplementos La medición del desarrollo infantil se realizó mediante el Cuestionario de detección previa al desarrollo. El análisis de los datos se realizó con el programa SPSS 25 y el análisis estadístico con la prueba de Kruskal-Wallis, estratificación y Chi-Cuadrado. La muestra estuvo conformada por 155 niños y 146 niñas, con un nivel económico 90,36 % de clase media baja y 86,7 % de madres según el Umbral de Reporte de Ingreso (IRT). Los resultados mostraron que no hubo diferencia de desarrollo entre los niños cuyas madres embarazadas fueron tratadas con GTK, GBF y GEK (p=0,294). Sin embargo, el puntaje promedio de los preescolares del grupo moringa (GEK) mostró un mejor desarrollo. Después del control, los resultados de la prueba de estratificación mostraron que hubo diferencias en el desarrollo de los preescolares en función de la participación de Educación y desarrollo de la primera infancia (ECED) en la categoría "no" en los tres grupos (p = 0,022). Dar suplementos de hojas de Moringa durante el embarazo puede ser una alternativa a las tabletas de sangre, además de la necesidad de atención de los padres para maximizar el desarrollo infantil a través de la lactancia materna exclusiva continua hasta los 2 años, la estimulación del desarrollo temprano y la participación de los niños en las clases de ECED.

Palabras clave*: Embarazadas, hojas de Moringa, desarrollo del niño preescolar.*

INTRODUCTION

Recent evidence reinforces the importance of a woman's nutritional status at conception and during pregnancy, in addition to maternal health, and to ensure healthy fetal development and growth. There are 32 million Small Gestational Age babies each year, which is about 27 % of all births in low- and middle-income countries. Infants with fetal growth retardation also have a significantly increased risk of stunting in the first 1 000 days of life and several types of non-communicable diseases as adults (1).

The Global Nutrition Report, which evaluates the impact of poor consumption patterns on global health, found that despite some progress in improving nutrition, malnutrition rates persist. Worldwide in 2021, there were 149.2 million children < 5 years old who were stunted, 45.9 million were wasting, and 38.9 million children were overweight (2). The nutritional status of the mother is very influential on the health of the child from fetus to adulthood. For a mother, good nutrition is the key to a child's survival and will affect its growth (3). Starting in the uterus until the age of two years is a golden and critical period for growing and developing both physically, mentally, and socially. In that period, the brain will experience rapid development of about 80 % and become a determinant of the quality of human resources in the future (4).

Children with very severe levels of malnutrition result in impairment or hindrance in development. Even children with poor nutritional status have the potential to lose IQ by 10-13 points or decrease intelligence levels (4). Based on World Bank data, in 2017 shows around 250 million children under 5 years old have a risk of not being able to achieve maximum development

(Sub-directorate of Education and Social Welfare Statistics, 2018). A study by Zhang et al., in 2018, estimated that there are more than 200 million toddlers in the world experiencing impaired cognitive and social-emotional development. This condition is at least influenced by various social, biological, and psychological factors. In developing countries, evidence shows four main risks: inadequate cognitive stimulation, stunting, iodine, and iron deficiency, which affect child development by 20 %-25 % (6).

Micronutrient deficiency during pregnancy is common in women of childbearing age in births in low- and middle-income countries, this condition is one of the important risk factors that can affect child development. The global policy recommends giving iron and folic acid (IFA) supplements to pregnant women (7). Micronutrients are very important for the development of the child's brain during the womb and infancy. The condition is an important period for brain formation, laying the foundation for the development of cognitive, motor, and socio-emotional skills in childhood and adulthood. Children with developmentally limited to these skills early in life are at risk for neuropsychiatric problems, poor schooling, low-skill jobs, and poor child care, which contribute to the transmission of intergenerational poverty (8).

Pregnant women are a vulnerable group of nutrition and are one of the objectives of the Supplementary Feeding program which aims to overcome malnutrition by focusing on the needs of macronutrients and micronutrients to prevent low birth weight (Ministry of Health RI, 2018). Efforts to prevent anemia in pregnant women also need to be carried out in an integrated manner to provide other micronutrients in utilizing the potential of local resources so that they are easily accessible to the community and sustainable. One of the potential ingredients of local food that is rich in micronutrients and widely available and can be cultivated is Moringa leaves (*Moringa oleifera*). Moringa trees are easily found throughout Indonesia and even found in many areas of South Sulawesi (10).

The results of the nutritional composition analysis of Moringa leaf extract varietal South Sulawesi in 100 g are protein 12.31 %, fat 18.62 %, provitamin A (β-carotene) 313.47 mg, vitamin E 1549.4 mg, vitamin C 1514.96 mg, iron (Fe) 9.72 mg, zinc (Zn) 3.7 mg and selenium 47.45 mg (11). Moringa leaf supplementation in the group of pregnant women has been carried out in several stages by the Research Team from Hasanuddin University (UNHAS), Jeneponto Regency, in six sub-districts, where the intervention was first carried out in 2016 - 2017, starting in the second trimester of pregnant women, for 90 days. 616 pregnant women were included in the study by considering shelter, environmental sanitation, and the severity of anemia. Intervention in pregnant women was divided into 3 groups, namely Moringa Flour (GTK), Iron Folate (GBF), and Moringa Extract (GEK), and demonstrated that Moringa leaf's tended to protect from undernutrition to the infant but not stunting (12).

Based on the background, and to assess the long-term effects of Moringa leaf supplementation, it was conducted a follow-up study in the preschool age group (5-6 years) born from mothers treated with Moringa leaf supplements during pregnancy, on child development (gross motor, fine motor, speech/language, and social independence) in Jeneponto Regency.

MATERIALS AND METHODS

Study Design and Participants

This study was an analytical observational study, with a cross-sectional design. It was held from November 2022 to January 2023 in six sub-districts in Jeneponto Regency, namely Kelara, Tarowang, Bontoramba, Bangkala, Tamalatea, and Binamu. The population in this study was all children whose mothers received Moringa supplements in the form of flour (GTK) and extract (GEK) as well as iron folate supplements (GBF) during pregnancy and were in six sub-districts in Jeneponto Regency. The number of samples was selected by purposive sampling, namely 301 preschool children, spread across Tamalatea District (GTK=19, GBF=15, GEK=14), Bangkala (GTK=19, GBF=17, GEK=17), Bontoramba (GTK=17, GBF=20, GEK=17), Binamu (GTK=20, GBF=21, GEK=17), Tarowang (GTK=18, GBF=18, GEK=19), and Kelara (GTK=10, GBF=16, GEK=8).

Instruments and Procedures

This study used primary data, in the form of direct interviews with mothers or children's families using questionnaires that have been provided to obtain data on child characteristics and family socioeconomics in the form of child sex, child participation in ECED, maternal education, maternal occupation, and parental income. In addition, measurements of children's nutritional status, and parental stimulation were also measured using stimulation questionnaires adapted from KPSP and measurements of child development using the Pre-Developmental Screening Questionnaire (KPSP). The secondary data used were supporting data from previous studies such as low birth weight (BBLR), exclusive breastfeeding history, immunization, and division of intervention groups.

Researchers need 20-30 minutes to collect the necessary data because measuring child development requires the readiness of the child to be measured so that the data obtained is accurate. There are instruments for measuring child development using KPSP such as stationery (pen and paper), baseball, 4-color picture paper, picture paper with a "+" sign, and a box shape.

Data analysis was performed using the SPSS package, version 25, with Kruskal-Wallis and Chi-Square tests for bivariate analysis and the Multinomial Regression Analysis test for multivariate analysis. This research has been approved by the Health Research Ethics Committee of Hasanuddin University with the recommendation of ethical approval number: 12854/UN4.14.1/TP.01.02/2022.

RESULT

Respondents were distributed across six sub-districts in Jeneponto Regency where GTK and GBF were highest in Binamu District, and GEK was highest in Tarowang District. The male sex was highest in the GBF group at 57 % and the female was highest in GEK at 52.7 %, not BBLR was highest in GTK at 98.1 % and BBLR was highest in GBF at 7.5 %, History of Exclusive Breastfeeding was highest in GBF and GEK at 57 %, and not exclusive breastfeeding was highest in GTK 44.7 %, Complete immunization history was highest in GTK at 53.4 and incomplete was highest in GTK at 53.4 %. Good category parental stimulation was highest in GTK at 72.8 % while the less category was highest at GEK at 30.8 %. For ECED participation, the most GEK group entered ECED at 89 % and the most non-ECED participation is GBF at 21.5 %, good nutritional status was highest in GBF at 90.7 % and malnutrition was highest at GEK at 18.7 %. Based on maternal education, elementary school was highest in GTK (10.7 %), elementary school was highest in GBF (44.9 %), junior high school was highest in GEK (23.1 %), and high school was highest in GTK (26.2 %). Diploma and S1 were highest in GBF (9.3). Family income <Rp.1 million/month was highest in GBF (13.1 %), ≥ income of 1 million-3 million/month was highest in GTK (81.6 %), and > 3 million/month was highest in GBF (12.1 %). The results of the Chi-Square test on the characteristics of the child's birth weight showed a difference in the intervention group when pregnant women with the child's birth weight ($p< 0.005$) (Table 1).

As shown in Table 2, from 301 respondents in six sub-districts in Jeneponto Regency, the development of preschool-age children in the "appropriate" category was higher in the GEK group at 68.1 %, while the development of children in the "dubious" category was higher in the GBF group at 33.6 % and in the development of children in the "deviant" category was higher in the flour group at 11.7 %.

Bivariate analysis using the Kruskal-Wallis's test for aspects of preschool child development (5-6 years) obtained $p = 0.286$ where $p > 0.05$. This shows that H0 is accepted, and Ha is rejected which means there is no difference in the development of preschool children (5-6 years) between GTK, GBF, and GEK groups. Furthermore, based on the average test results for aspects of the development of preschool children (5-6 years), the GEK group has a higher mean value of 8.81 compared to GTK and GBF (Table 3).

Stratification Test Analysis Table 4 shows the development of "appropriate" category preschool children with good nutritional status is highest in GEK (71.6 %) and lowest in GBF (56.7 %), Development of "appropriate" category preschool

Table 1. Frequency Distribution based on Distribution, Characteristics of Pre-school Children (5 - 6 years), and Family Socio-Economy in Jeneponto Regency

Characteristic	GTK (n=103)		GBF (n=107)		GEK (n=91)		P value*
	n	%	n	%	n	%	
Gender							
Male	51	49.5	61	57	43	47.3	0.346
Woman	52	50.5	46	43	48	52.7	
Birth weight							
No BBLR	101	98.1	99	92.5	88	96.7	0.121
BBLR	2	1.9	8	7,5	3	3.3	
History of exclusive breastfeeding							
Exclusive	57	55.3	61	57	52	57.1	0.959
Not Exclusive	46	44.7	46	43	36	42.9	
Immunization							
Complete	55	53.4	53	49.5	41	45.1	0.510
Incomplete	48	46.6	54	50.5	50	54.9	
Nutritional Status (BW/BH)							
Good Nutrition	87	84.5	97	90.7	74	81.3	0.157
Malnutrition	16	15.5	10	9.3	17	18.7	
Parental stimulation							
Good	75	72.8	76	71	63	69.2	0.860
Less	28	27.2	31	29	28	87	
ECE Participation							
Yes	89	86.4	84	78.5	81	89	0.100
Not	14	13.6	23	21.5	10	11	
Mother's Education							
Did not finish	11	10.7	9	8.4	6	6.6	0.828
elementary school	40	38.8	48	44.9	39	42.9	
SD	17	16.5	20	18.7	21	23.1	
JUNIOR	27	26.2	20	18.7	18	19.8	
SMA	8	7.8	10	9.3	7	7.6	
Diploma / S1							
Mother's Work							
Housewife	93	90.3	92	86	76	83.5	0.67
Farmer/seaweed/garden laborer	2	1.9	4	3.7	4	4.4	
Honorary	3	2.9	6	5.6	7	7.7	
Self-employed	3	2,9	4	3.7	3	3.3	
Civil servants/teachers	3	1.9	1	0.9	1	1.1	
Family income							
< Rp. 1 million/month	13	12.6	14	13.1	10	11	0.570
≥ Rp. 1 million – 3 million / month	84	81.6	80	74.8	71	78	
> Rp. 3 million/month	6	5.8	13	12.1	10	11	

Source: Primary Data, 2023, *Chi-Square test.

children who have a history of not being low weight, highest in GEK (69.3 %) and lowest in GBF (56.6 %), Development of "appropriate" category preschool children who have a history of exclusive breastfeeding, highest in GEK (65.4 %) and lowest in GEK (54.4 %), Development of preschool children in the "appropriate" category based on ECE participation in the "yes"

Table 2. Distribution of Respondent Distribution Based on the Development of Preschool Children in Jeneponto District

Preschool-Age Child Development	GTK		GBF		GEK		Total	
	n	%	n	%	n	%	n	%
Appropriate	60	58.3	62	57.9	62	68.1	184	61.1
Doubtful	31	30.1	36	33.6	19	20.9	86	28.6
Diverge	12	11.7	9	8.4	10	10.3	31	10.3
Total	103	34.2	107	35.5	91	30.2	301	100.0

Source: Primary Data, 2023

Table 3. Average Differences in Development Aspects of Pre-School Children (5-6 Years) Between GEK, GTK, and GBF Groups

Intervention Group	Mean±SD	N	Min	Max	*p Value
GTK	8.53±1.56	103	3	10	0.294
GBF	8.56±1.47	107	4	10	
GEK	8.81±1.44	91	5	10	

Source: Primary Data, 2023, * Kruskal-Wallis Test

category, highest in GEK (67.5 %) and lowest in GTK (65.2 %), Development of preschool children in the "appropriate" category based on immunization history in the "complete" category, highest in GEK (73.2 %) and lowest in GBF (58.5 %), Development of preschool children in the "appropriate" category based on good parental stimulation, highest in GEK (71.4 %) and lowest in GTK (56.3 %), The development of preschool children in the "appropriate" category based on the mother's education level in the category "not completing elementary school", highest in GTK (54.5 %) and lowest in GBF (44.4 %), Development of preschool children in the "appropriate" category based on the mother's work in the category "farmer/seaweed farmer/ grass worker/planter", was the same in the three groups, namely 50 % each, Development of preschool children in the "appropriate" category based on family income in the category "< Rp. 1 million / month", highest at GTK (61.5 %) and lowest at GBF (57.1 %). In the ECE participation category "no" shows there is a difference in the development of preschool-age children between GTK, GEK, and GBF with p values of 0.022 < 0.05.

DISCUSSION

This is a follow-up study to assess the difference in the development of children whose pregnant mothers received moringa supplementation (extract and flour) and iron folate tablets. The results show that there is no difference in the development of preschool-age children between the three groups (GEK, GBF, and GTK) with a value of p>0.05. However, the average value for the development of preschool children (5-6 years) indicates that the GEK group has a higher mean value of 8.81 when compared to GTK (8.53) and GBF (8.56). Thus, even though there were no statistical differences in the development of preschool children between the three groups (p>0.05), the average showed that preschool children in the GEK and GTK groups had a better development tendency than the GBF group.

This study is in line with research conducted by Hastuti, 2020 in a follow-up study in children aged in ranges of 18-24 months showing no difference between the three groups, Moringa supplements

Table 4. Results of Pre-School Child Development Stratification Test (5-6 Years) on Control Variables based on Intervention Group in Pregnant Women (GTK, GEK, and GBF)

Control Variables	Child Development	GTK		GEK		GBF		P Value*
		n	%	n	%	n	%	
Nutritional Status								
Good Nutrition	Appropriate	53	60.9	53	71.6	55	56.7	0.100
	Doubt	24	27.6	12	16.2	34	35.1	
	Diverge	10	11.5	9	12.2	8	8.2	
Malnutrition	Appropriate	7	43.8	9	52.9	7	70	0.692
	Doubt	7	43.8	7	41.2	2	20	
	Diverge	2	12.5	1	5.9	1	10	
Birth weight								
Not LBW	Appropriate	58	57.4	61	69.3	56	56.6	0.250
	Doubt	31	30.7	19	21.6	35	35.4	
	Diverge	12	11.9	8	9.1	8	8.1	
LBW	Appropriate	2	100	1	33.3	6	75	0.307
	Doubt	0	0	0	0	1	12.5	
	Diverge	0	0	2	66.7	1	12.5	
History of Exclusive Breastfeeding								
Yes	Appropriate	31	54.4	34	65.4	34	55.7	0.564
	Doubt	19	33.3	11	21.2	21	34.4	
	Diverge	7	12.3	7	13.5	6	9.8	
No Breast Milk	Appropriate	29	63	28	71.8	28	60.9	0.710
Ex-	Doubt	12	26.1	8	20.5	15	32.6	
	Diverge	5	10.9	3	7.7	3	6.5	
ECED Participation								
Yes	Appropriate	58	65.2	55	67.9	55	65.5	0.803
	Doubt	25	28.1	19	23.5	25	29.8	
	Diverge	6	6.7	7	8.9	4	4.8	
Not	Appropriate	2	14.3	7	70	7	30.4	0.022*
	Doubt	6	42.9	0	0	11	47.8	
	Diverge	6	42.9	3	30	5	21.7	
Immunization								
Complete	Appropriate	33	60	30	73.2	31	58.5	0.213
	Doubt	14	25.5	8	19,5	19	35.8	
	Diverge	8	14.5	3	7.3	3	5.7	
Incomplete	Appropriate	27	56.3	32	64	31	57.4	0.629
	Doubt	17	35.4	11	22	17	31.5	
	Diverge	4	8.3	7	14	6	11.1	
Parental Stimulation								
Good	Appropriate	50	66.7	45	71.4	53	69.7	0.590
	Doubt	18	24	10	15.9	18	23.7	
	Diverge	7	9.3	8	12.7	5	6.6	
Less	Appropriate	10	35.7	17	60.7	9	29	0.120
	Doubt	13	46.4	9	32.1	18	58.1	
	Diverge	5	17.9	2	7.1	4	12.9	
Mother's Education Level								
Did not finish elementary school	Appropriate	6	54.5	3	50	4	44.4	0.761
	Doubt	3	27.3	3	50	4	44.4	
	Diverge	2	18.2	0	0	1	11.1	

Continued in page 619…

…continuation Table 4. Results of Pre-School Child Development Stratification Test (5-6 Years) on Control Variables based on Intervention Group in Pregnant Women (GTK, GEK, and GBF)

Control Variables	Child Development	GTK		GEK		GBF		P Value*
SD	Appropriate	21	52.5	25	64.1	23	47.9	0.338
	Doubt	16	40	9	23.1	21	43.8	
	Diverge	3	7.5	5	12.8	4	8.3	
JUNIOR	Appropriate	10	58.8	16	76.2	12	60	0.787
	Doubt	4	23.5	3	14.3	5	25	
	Diverge	3	17.6	2	9.5	3	15	
SMA	Appropriate	18	66.7	13	72.2	14	70	0.684
	Doubt	6	22.2	2	11.1	5	25	
	Diverge	3	11.1	3	16.7	1	5	
Diploma and PT S1	Appropriate	5	62.5	5	71.4	9	90	0.485
	Doubt	2	25	2	28.6	1	10	
	Diverge	1	12.5	0	0	0	0	
Mother's Work								
IRT	Appropriate	55	59.1	52	68.4	51	55.4	0.227
	Doubt	27	29	16	21.1	34	37	
	Diverge	11	11.8	8	10.5	7	7.6	
Farmer/farmer	Appropriate	1	50	2	50	2	50	0.572
Seaweed/seaweed	Doubt	1	50	1	25	0	0	
aborer/planter	Diverge	0	0	1	23	2	50	
Mother's Work								
Honorary	Appropriate	2	66.7	6	85.7	5	83.3	0.297
	Doubt	0	0	1	14.3	1	16.7	
	Diverge	1	33.3	0	0	0	0	
Self-employed	Appropriate	0	0	2	66.7	3	75	0.071
	Doubt	3	100	0	0	1	25	
	Diverge	0	0	1	33.3	0	0	
Civil servants	Appropriate	2	100	0	0	1	100	0.135
	Doubt	0	0	1	100	0	0	
	Diverge	0	0	0	0	0	0	
Family Income								
< Rp. 1 M / Month	Appropriate	8	61.5	6	60	8	57.1	0.336
	Doubt	3	23.1	4	40	6	42.9	
	Diverge	2	15.4	0	0	0	0	
≥ Rp. 1 million –								
3 million / month	Appropriate	49	58.3	49	69	49	61.3	0.438
	Doubt	25	29.8	14	19.7	25	31.3	
	Diverge	10	11.9	8	11.3	6	7.5	
> 3M/Month	Appropriate	3	50	7	70	5	38.5	0.311
	Doubt	3	50	1	10	5	38.5	
	Diverge	0	0	2	20	3	23.1	

Source: Primary Data, 2023, *Chi-Square test

in the form of flour (GEK) and extract (GEK) as well as iron folate supplements (GTK), with a trend of personal social development, fine motor, language; and gross motor in GEK and GEK group children was better than in the GTK group (10).

The effect of supplementation during pregnancy on child growth and development has been widely studied. Prado et al., in research involving 487 children in Indonesia, found that in pregnant women who are malnourished or

anemic, the provision of Maternal Multiple Micronutrient Supplements during pregnancy can improve the motor and cognitive development of children up to the age of 3.5 years (8).

Child development is influenced by many factors based on the period of growth and development, namely prenatal, natal, and postnatal but broadly speaking, child development factors are divided into internal (genetic) and external (environmental) factors including parental stimulation, nutrition, and sex (13).

Development is a process that does not stop from conception to closing age. The development of offspring after birth is easier to observe. The development process of each individual is different, some are fast and slow. Nevertheless, every stage of development will move forward. Normal development does not mean being free from the risk of growth and development disorders. Risk factors can come from genetics, living environment such as family, society, physical, biological, socio-cultural environment, and more broadly the political-economic environment of a country. That is why it is important to pay attention to monitoring the child's development from every possible risk through developmental screening so that if suspicion is found, immediately carried out assessment, diagnosis, management, and referral are (14).

Murcia et al. evaluated the impact of supplementation during pregnancy on aspects of child development by assessing the relationship between iodine supplementation during pregnancy on cognitive or motor function in children, and although there was no link between the two variables they found a positive relationship between low urine sodium and low cognitive scores in childhood (15).

Moringa supplementation studies have been carried out in different stages of life, starting from pregnancy, and breastfeeding, and followed up to children aged 5-6 years with different variables. The use of moringa supplementation is an effort to utilize the local potential that is widely available in South Sulawesi, especially in Jeneponto Regency which is a suitable location for cultivating moringa plants. Moringa can grow in tropical and subtropical regions, so it is easily cultivated throughout the region. Moringa leaves contain many minerals, one of which is calcium which is referred to as a type of mineral that is important for growth, vitamins, and important phytochemicals such as tannins, sterols, terpenoids, flavonoids, and others. However, it is of concern that the composition of the nutritional content in moringa differs depending on the planting location (16).

Supplementation of pregnant and lactating women has a positive impact on growth and development in a birth. This study showed that the development of children was higher in the moringa group, namely GEK 68.1 % and GTK 58.3 % compared to the Iron folate group 57.9 %. Meanwhile, the development of doubtful group children was higher in the Iron folate group, which was 33.6 % compared to the GEK group at 20.9 and GTK at 30.1 %. Furthermore, the development deviated higher in the moringa group, namely GEK 10.3 %, GTK 11.7 %, and in the folate iron group 8.4 %. This categorical determination is based on the number of scores accumulated based on the developmental pre-screening questionnaire (KPSP).

The human brain is formed early and undergoes continuous development and change. The brain has a function as the center of memory, creating new skills, and receiving information. The brains of adults and children are different, where in children, the brain is plastic which positively means that the child's brain is more easily exposed to learning and enriched. This trait makes the child's brain more sensitive to developmental disorders that come from the environment such as poverty and lack of stimulation (14).

The results of the distribution of respondents based on parental stimulation show that children in the GEK group had the lowest presentation in the category of good parental stimulation (69.2 %) and the highest in the category of receiving less parental stimulation than the GTK and GBF groups at 30.8 %. According to Soetjiningsih and Ranuh (14), stimulation is one of the efforts in educating children and this must be done early even when the child is still in the uterus. Parental stimulation is likely one of the reasons why deviant development is higher in GEK than in GTK and GBF.

The stage of development of children 3-6 years is the preschool stage shows that physical growth will slow down but otherwise psychosocial and

cognitive development will increase. Preschoolers will expand the outdoor environment because playing is used to learn and develop relationships with the surrounding environment. There are three basic needs of children contained in the Convention on the Rights of the Child (1990), namely biomedical physical needs (foster care), emotions or compassion (compassion), and mental stimulation needs (sharpening). From an early age, a child needs to be stimulated to be able to develop motor, emotional-social, speech, cognitive, independence, creativity, leadership, moral and spiritual skills. Stimulation needs in children can be provided through formal, informal, and non-formal activities (17).

The results of the distribution analysis based on early childhood education indicated that the percentage of children who attended Early Childhood Education was highest in the moringa group, namely GEK 89 % and GTK 86.4 % compared to the iron folate group 84 %. The average results of developmental aspects in preschool children show that the average value of child development scores in the moringa group (GEK and GTK) tends to be higher than in the folate iron group, which is 8.81, 8.53 and 8.50, respectively, with a maximum value of 10. While the minimum score in the GEK group was higher than the other groups, where the minimum value in each was GEK = 5, GTK = 3, and GBF = 4. This shows that there is a tendency for child development in the Moringa group (GEK) to be better than in the folate iron group even though statistically it does not show any difference ($p>0.05$).

The brain is one of the important organs that require high nutritional intake to function optimally. Nutritional deficiencies in certain phases and periods will cause developmental problems, especially if it lasts for a long time. Thus, the mother's nutritional status during pregnancy is an important part of the development of an individual. For example, mothers who experience folate deficiency during pregnancy have a high risk of giving birth to babies with neural tube defects; another example is pregnant women whose iron deficiency can cause nerve problems in children that cannot be repaired. Fetuses that do not experience iron deficiency during the womb can support nerve metabolism, the development of dendrites and synapses, neurotransmitter synthesis, and the onset of myelination (18).

Moringa supplementation in pregnant women has been shown to increase hemoglobin (Hb) levels and prevent anemia in pregnant women or the impact of other micronutrient deficiencies. Nurdin et al. (19) in Jeneponto showed that moringa supplements can prevent anemia. In addition, Arundhana et al. (20) observed in the same group of pregnant women that the size of the baby's placenta presented a better size than the placenta of babies whose mothers were only given iron folate. It has been reported that due to the presence of methanol, moringa extracts show antioxidant capacity. Using DPPH (2,2-Diphenyl-1-Picrylhydrazyl) to evaluate the antioxidant capability to scavenge free radicals it was shown that moringa extract contains bioactive compounds able to donate hydrogen to free radicals thereby removing odd electrons that are responsible for free radical generation. Additionally, it is capable of offering protection against oxidative damage caused by free radicals, thus acting as a free radical scavenger (21); proffering a protective effect to cells and minimizing the destructive effect of free radicals on DNA that causes damage to placental growth and fetal weight.

The condition of stunting in children affects development. Stunting is an impact that occurs due to chronic malnutrition because the development requires adequate nutrients such as iodine, folic acid, iron, and zinc. These may cause neurodevelopmental disorders, changes in neurogenesis and cell apoptosis as well as dysfunction of synapses resulting in developmental delay that affects areas of the brain involved in cognition, memory, and locomotor skills. The relationship between stunting and cognitive function also has been demonstrated, and children who were persistently stunted had significantly lower cognition than children who were not stunted. The effects of stunting on neurocognitive function are severe. Stunted children have stunted brains and live stunted lives, preventing entire communities from developing, and affecting other aspects of development, such as motor and social independence in children (22).

A follow-up study conducted by Basri et al. (23) showed that administration of *Moringa*

oleifera extract during pregnancy prevents the incidence of stunted growth in children aged 30-42 months, where children in the moringa intervention showed the lowest prevalence of stunting. In the same study, it was also found that motor development in children is associated with the incidence of stunting, underweight, and wasting, possibly because one of the determinants of stunting is low birth weight, and moringa supplementation in pregnant women can prevent these.

All aspects that affect a child's development are equally important internally and externally. To achieve quality in child development it is required comprehensive and integrated knowledge starting from the uterus until the child reaches the age of 6 years. That is why is important the role of the mother, and her adequate physical and mental state, since she plays multiple roles in a child's development, as she is a teacher in every aspect of a child's developmental growth – social emotional, physical, cognitive, and independence. In a psychological sense, the relationship between mother and child: emotional warmth, personal care, and sensory stimulation are considered essential to healthy personality development and are particularly important in infancy and the early years of childhood.

In this regard, the level of maternal education in this study after analysis by excluding intervention group factors during pregnancy (GEK, GTK, and GBF) showed statistical differences in child development based on maternal education level ($p<0.05$). Mothers with higher education and sufficient knowledge of child development tend to pay more attention to their children's development. A mother who does not pay much attention to the development of her child results in developmental delays in the child. The consequence is that children become insecure, hesitant in acting, and less happy so there is minimal interaction and become introverted figures (24).

The frequency distribution of preschool and family socioeconomic characteristics, namely in maternal work, showed above 80 % among the three groups as housewives, family income above 70 %, namely ≥ Rp. 1 million – 3 million per month among the three groups, children's nutritional status was good above 81 %, complete immunization history above 45 %, exclusive breastfeeding history above 50 % and low birth weight above 91 % even though there were no statistical differences. For child development, these variables are part of parents' affection and attention to their children in meeting their needs that can support their growth and development. In traditional families that consider the wife as their place at home and the husband who earns a living is slightly starting to shift, although the mother also helps to make a living, if the husband/father is able to collaborate in parenting (the wife/mother does not carry a double burden) then the environment has a positive impact on the development of children, including children trained to cooperate, responsibility, help, and affection. A child has the right to receive good care from his parents including the fulfillment of nutrition (food), health care, education, and protection to optimize mental, emotional, and social development in children. In addition, socioeconomic circumstances and parenting patterns also have a role in child development (14).

CONCLUSIONS AND RECOMMENDATIONS

There was no difference in the development of pre-school age children (5-6 years) between the Moringa Extract Group (GEK), Moringa Flour Group (GTK), and Folate Iron Group (GBF), but based on the average value there was a tendency for better child development in the Moringa group when compared with the iron folate group. Other factors affect child development, such as children's participation in Early Childhood Education and Development (ECED), history of exclusive breastfeeding, and parental stimulation. Moringa supplementation in pregnant women can be used as an alternative to iron folate tablets as a form of utilizing the local potential and the importance of providing child development support such as stimulation of children from the womb to birth and kindergarten participation to maximize developmental potential in children.

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