International Journal of Aquatic Science
ISSN: 2008-8019
Vol 12, Issue 03, 2021

Effects Of Psychosocial Stimulation And Daily Egg Consumption On The Nutritional Sstatus Of Stunted Children Aged 6-23 Months

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Abstract:
BACKGROUND
The prevalence of undernourished children, especially stunting, has remained high in developing countries. In Indonesia, stunted children have accounted for 30.8% in 2018 (Riskedas, 2018). Stunting is the most serious problem that alters the growth and development of children. Causes of stunting are multifactorial, including the lack of food intake and psychosocial stimulation. This study examines the effect of psychosocial stimulation intervention and daily egg consumption on the nutritional status of stunted children aged 6-23 months.
METHOD
We did a quacy-experiment study with cluster sampling. Of 315 children were assigned into 5 groups, in which 3 intervention groups with stunted children, namely PSG group receiving psychosocial stimulation, EGG Group was given 1 egg per day, PSG+EGG group receiving psychosocial stimulation and eggs. The other 2 groups were control groups (with no intervention), SCG group with stunted children and NCG group with non-stunting. The intervention was carried out for 2 months.
RESULTS
The median delta of body weight was highest in PSG, significantly different from the other 4 groups. There was no significant difference among EGG, PSG+EGG, SCG, and NCG groups. The highest median body length delta was at PSG+EGG, significantly different from EGG, SCG, and NCG. The second highest is that PSG has a significant difference with SCG and NCG. Same with BB, the highest WHZ delta is in PSG, significantly different from the 4 other groups. The lowest was on PSG+EGG, substantially different from SCG. The highest HAZ delta at PSG+EGG (0.76+0.52) was significantly different ($p<0.05$) with SCG and NCG, following PSG (0.58+0.44) and EGG (0.51+0, 76) both are significantly different from NCG. The median delta WAZ was highest in PSG, substantially different from the other 4 groups. There was no significant difference between EGG, PSG+EGG, SCG, and NCG group.

In terms of macronutrients intake, the PSG+EGG group has the highest delta of energy and carbohydrate intake among groups. Meanwhile, EGG group had the highest mean delta of protein and fat intake.
CONCLUSION
In conclusion, our study suggested that psychosocial stimulation had the best effect on improving acute nutritional problems, which is indicated by body weight, WHZ and WAZ. Either psychosocial stimulation or egg intervention had a significant impact in improving chronic nutrition. However, combining these interventions results in greater improvement of chronic malnutrition such as body length and HAZ.

Keywords : Psychosocial stimulation, eggs, stunting, age 6-23 months, children

1. INTRODUCTION

The quality of human resource is dependent on several factors including individual level of health and nutrition[1]. Globally, it is estimated that nearly 165 million children under 5 y are stunted or short for their age (HAZ score $\geq$ -2SD) [2]. In Indonesia, the prevalence of stunted children has remained high, which was accounted for 30.8% in 2018. (Riskesdas,2018), whereas in Majene regency the prevalence rate was 40.4% [3].
Stunting children are more vulnerable to suffer from any illness that can alter their growth and development. [4] . Impaired linear growth was also associated with cognitive impairment, resulting in lower school achievement and educational performance, which in turn reduced productivity and earning capacity. [5]. Moreover, stunted children had greater risk of developing non-communicable diseases such as cardiovascular disease and diabetes in later life [6]. They also had a 5.5 times higher risk of death than normal children[7]. Regarding disability and mortality burden, stunting in children aged 36 months or older contributes to approximately 9.4 million per year of lifelong disability.[8]. Evidence suggests that the appropriate intervention in the first 1000 days of life can prevent children from stunting[9].

2. MATERIALS AND METHODS

The design of the study was quacy-experiment, cluster sampling. The study was conducted in Majene regency, the highest stunting prevalence in West Sulawesi province. We identified 5 sub-distric (Pangali-Ali, Baru, Baurang,Galung and Totoli). There were 5 groups (3 intervention group and 2 control groups) of children aged 6-23 months. The total number of children in these location was 317 with 165 stunted (HAZ score < -2SD) and 152 normal status ((HAZ score > -2SD). Of 165 stunted children were assigned into 3 intervention groups and a control group; namely PSG group receiving psychosocial stimulation, EGG group receiving an egg every day, PSG+EGG group receiving egg and a psychosocial stimulation and SGC group (control) receive nothing. The other control group was NCG group (non-stunting) receiving no intervention. Psychosocial intervention was performed by form of animation that uploaded into mothers or babysitter's smart phone. The researcher trained mothers on how to use the animation to their children. Eggs were distributed weekly. The researcher visited mothers weekly to record and monitor compliance of practicing psychosocial stimulation and egg consumption. Besides, the history of illness in the previous week was also recorded. WHO Anthro software was used to calculate the nutritional status of children. Data were then analysed using SPSS versi 25.0. Paired t test and Wilcoxon test were performed . Significance was set at

$P < 0.05$

3. RESULT

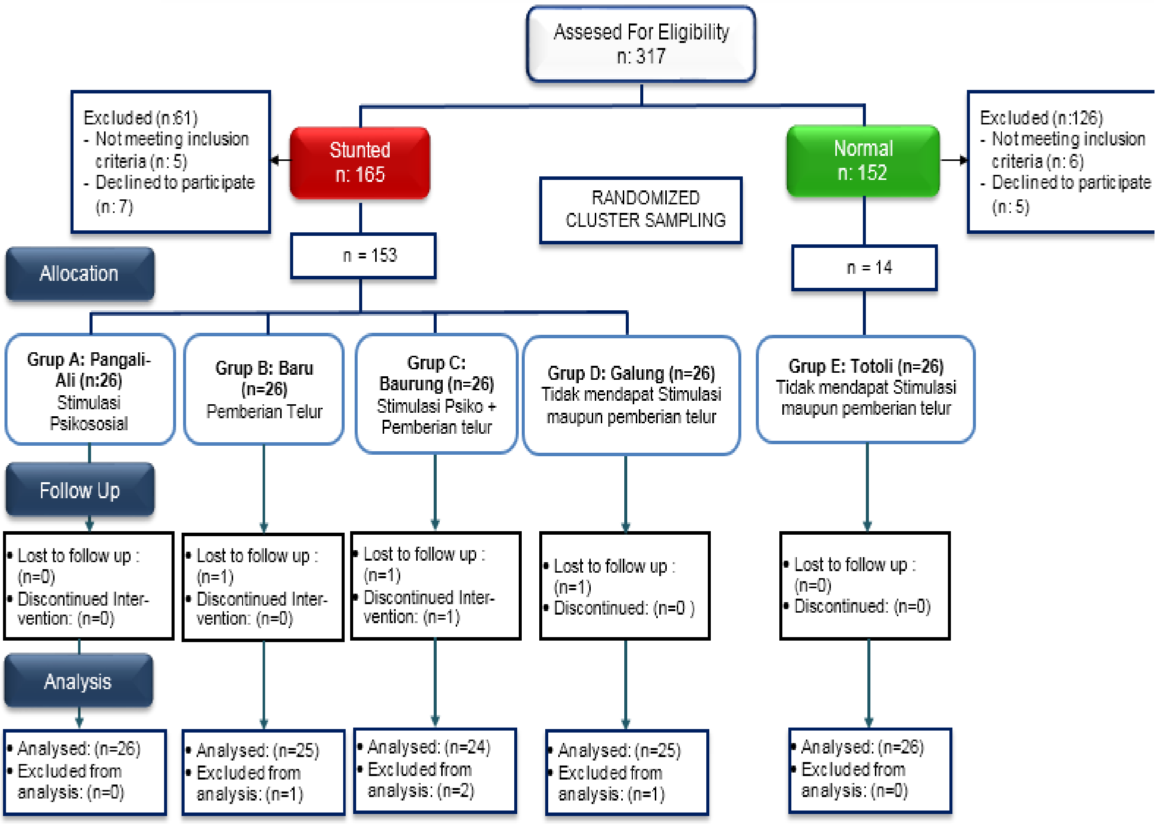

Table 1. Maternal and children characteristics at admission

Variable	Group									
	PSG` (n=26)		EGG (n=25)		PSG+EGG (n=24)		Control (stunting) SCG (n=25)		Control (Non-stunting) NCG (n=26)	
	N	%	n	%	n	%	n	%	n	%
Mother's Education										
Elementary school	9	34.6	7	28.0	6	25.0	8	32.0	12	46.2
Junior high school	4	15.4	5	20.0	6	25.0	2	8.0	4	15.4
Senior high school	11	42.3	10	40.0	9	37.5	9	36.0	7	26.9
University	2	7.7	3	12.0	3	12.5	6	24.0	3	11.5
Mother's Job										
Employed	2	7.7	2	8.0	0	0.0	8	32.0	3	11.5
Unemployed	24	92.3	23	92.0	24	100.0	17	68.0	23	88.5
Sex of children										

Male	13	50.0	12	48.0	11	45.8	14	56.0	17	65.4
Female	13	50.0	13	52.0	13	54.2	11	44.0	9	34.6
Age group										
6-11 months	5	19.2	10	40.0	5	20.8	5	20	17	65.4
12-24 months	21	80.8	15	60.0	19	79.2	20	80	9	34.6

Table 1 depicts the distribution of characteristics of mothers and their children. Majority of mothers in three intervention groups graduated from senior high school. Conversly, in non-stunting group, most mothers had elementary education (46.2%). Large proportion of mothers in all groups were unemployed. The sex of children in the psychosocial group had the same for both male and female, whereas the other groups were different. In terms of age, children were mostly in age group of 12-24 months, except for non-stunting group, of which 65.4% was in 6-11 months.

Variable	PSG (n=26)	EGG (n=25)	PSG+EGG (n=24)	Control (stunting) SCG (n=25)	Control (Non-stunting) NCG (n=26)
	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)
Weight					
Baseline	8.05 (5.80-10.40)	7.90 (5.60-10.60)	7.8±6.10-11.00)	8.80 (5.60-11.10)	8.87 (6.80-11.10)
Endline	10.30 (8.00-12.50)	8.20 (6.20-12.20)	8.70 (6.70-11.90)	8.70 (1.10-17.60)	9.50 (7.70-11.20)
P-value	**0.000****	**0.001****	**0.001****	0.166	**0.001****
Δ	1.85 (0.50 - 3.70) a,b,c,d	0.50 ((-0.90)-1.60) a	0.50 ((-1.00)-2.40) b	0.50 ((-10.00)-7.40) c	0.55((-1.20)-2.30) d
Length					
Baseline	71.15 (61.4--79.50)	70.40 (61.80-79.60)	70.90 (60.80-78.00)	71.70 (62.20-81.30)	75.05 (64.70-79.50)
Endline	75.00 (8.00-12.50)	73.90 (65.60-84.10)	76.20 (67.70-82.20)	75.70 (64.00-84.80)	77.90 (69.90-82.90)
P-value	**0.000****	**0.000****	**0.000****	**0.000****	**0.001****
Δ	3.90 (1.50-5.50)a,b	3.30 (1.30-11.60)c,d	4.60 ((-3.30)-14.50)c,e,f	3.30 (1.00-7.50)a,e	2.20 (0.10-7.50)b,d,f
WHZ					
Baseline	-0.47 ((-2.76) - 2.62)	-0.54((-2.49)-2.07))	-0.79 ((-2.10) - 1.03)	-0.14 ((2.20)-1.79)	-0.53 ((-2.70)-1.29)
Endline	0.72 ((-1.63) - 2.40)	1.11 ((-2.96)-0.93)	-1.17 ((-2.65)-1.29)	-1.31 ((-3.59)-0.40	0.41*((-2.05)-1.73)
P-value	**0.000****	**0.026****	**0.003****	0.609	0.517
Δ	1.46 ((-0.65) - 3.85)a,b,c,d	-0.39 ((-2.70) - 0.62)a	-0.51 ((-2.45) - 0.70)b,e	-0.11 ((-2.62) - 2.52)c	0.16 ((-2.03) - 2.56)d,e
HAZ	NORMAL				
Baseline	-2.61±0.47	-2.6±0.43	-2.72±0.49	-2.52±0.43	0.31±1.96
Endline	-2.02±0.61	-2.09±0.81	-1.96±0.55	-2.29±0.75	-0.01±1.64
P-value	**0.000***	**0.003***	**0.000***	0.069	0.055
Δ	0.58±0.44 a	0.51±0.76 b	0.76±0.52 c,d	0.23±0.60 c,e	-0.31±0.80 a,b,d,e
WAZ					
Baseline	-1.60 ((-3.80)-0.55)	-1.76 ((-3.68)-(-0.35))	-1.97 ((-2.82)-(-0.53)	-1.12 ((-3.18)- 0.19)	-0.36 ((-2.58) - 1.56)
Endline	-2.65 ((-2.30)-1.08)	-1.70 ((-3.58)-(-0.24))	-1.91 ((-3.03)-(-0.32)	-1.31 ((-3.59)- 0.40)	-0.41 ((-2.05) - 1.73
P-value	**0.000****	0.194	0.920	0.925	0.79
Δ	1.27 ((-0.05) -	0.80 ((-1.73) -	0.85 ((-1.29) -	-0.11 ((-1.63)	0.00 ((-1.97) -

	3.19)a,b,c,d	0.88)a	1.27)b	- 1.73c	1.74d

Table 2. Changes on nutritional status of children

**Test Paired t-test; ** Wilcoxon test; Level of Significant <0.05*

The same letter means a significant difference (ANOVA and Tukey's test for normally distributed data; Kruskall Wallis and Mann Whitney for data not normally distributed).

The impact of intervention on nutritional status is reported in table 2. The highest median delta of body weight was in PSG group with 1.85 (0.50-3.70), (p<.0.05) and there was no significant difference among EGG, PSG+EGG, SCG and NCG group. The highest median delta body length was on PSG+EGG with 4.60 (-3.30)-7.50),(p<0.05) significantly different from EGG , SCG and NCG (p<0.05). The second highest was PSG (3.90 (1.50-5.5-), significantly different from SCG and NCG. Similar with body weight, the highest median delta of WHZ was PSG group with 1.46 ((-065)-3.85), significantly different from other 4 groups. The lowest was in PSG+EGG (-0.51 ((-2.45)-0.70), substantially different from SCG. The highest HAZ delta at PSG+EGG (0.76+0.52) was significantly different (p<0.05) with SCG and NCG, following PSG (0.58+0.44) and EGG (0.51+0, 76) both were significantly different from NCG. The highest median delta of WAZ was in PSG with 1.27 ((-0.05)-3, 19). No significant different among other groups.

The changes of macronutrients intake was presented in table 3. There was a significant difference between the mean energy intake before and after the intervention on PSG, EGG and PSG+EGG with p < 0.05. In the control groups either SGC or NCG , the mean intake was not significantly (p> 0.05). The highest change of energy intake was in PCG+EGG group. Similarly, on protein intake, there was a significant difference in PSG,EGG,PSG+EGG and SGC group (p<0.05). In terms of fat intake, it can be seen that there were only 2 intervention groups with significantly different of fat consumption (p<0.05) whereas the other 3 groups the mean value of fat intake was not significantly different . The mean delta of carbohydrate intake on all groups did not differ significantly (p>0.05) with the biggest change of carbohydrate consumption was in PSG+EGG group with 13.21±58.83.

Table 3. Changes in the amount of macronutrients intake among groups

Variable	**PSG (n=26)**	**EGG (n=25)**	**PSG+EGG (n=24)**	**Control SGC (stunting) (n=25)**	**Control NCG(Non-stunting) (n=26)**
	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)	Mean ± SD / Median (Min-Max)
Energy					
Baseline	771.35±191.74	865.93±165.47	783.49±183.32	747.65±250.98	886.38±232.63
Endline	943.03±235.91	1077.18±217.58	1018.48±297.24	681.71±269.85	796.1±229.09
P-value	**0.001***	**0.000***	**0.002***	0.332	0.141
Δ	171.68±243.86 a	211.24±215.56 b	234.98±338.69 c	-65.94±332.98 a, b, c	90.27±303.11 a, b, c

Protein					
Baseline	17.60 (9.90-34.00)	23.60 (13.20-33.00)	22.70 (10.60-32.30)	20.50 (12.50-29.80)	24.90 (15.00-47.50)
Endline	23.70 (15.20-49.30)	29.30 (14.40-45.25)	29.25 (11.70-71.20)	23.50 (13.00-40.10)	22.95 (15.20-49.60)
P-value	**0.019****	**0.002****	**0.006****	**0.048****	0.694
Δ	0.25 ((-7.60) - 33.40)	6.1 ((-7.40) - 32.00)a	5.65 ((-19.20) - 43.60)	2.10 ((-13.10) - 22.30)b	1.9 ((-27.80) - 24.20)a,b
Fat					
Baseline	38.48±10.51	26.74±11.93	27.97±18.73	31.98±14.05	31.15±13.37
Endline	40.25±15.82	49.21±16.22	42.01±16.05	24.8±14.84	31.89±16.49
P-value	0.624	**0.000***	**0.033***	0.12	0.874
Δ	1.76±18.17 a	22.46±20.83 a, b, c	14.03±30.27 d	-7.18±22.27 b, d	0.74±23.62 c
Carbphydrate					
Baseline	107.88±22.82	116.49±29.11	112.45±45.19	104.93±22.93	108.23±27.9
Endline	119.54±26.72	126.25±18.98	125.66±33.67	99.69±31.3	102.2±27.51
P-value	0.089	0.154	0.241	0.519	0.481
Δ	11.65±3.54	9.76±33.15	13.21±58.83	-5.24±40.08	-6.03±43.02

**Test Paired t-test; ** Wilcoxon test; Level of Significant <0.05*
The same letter signifies a significant difference (ANOVA and Tukey's test for normally distributed data; Kruskall Wallis and Mann Whitney for data not normally distributed).

4. DISCUSSION

Our study found that psychosocial stimulation alone had the best effect on improving acute nutritional status, as indicated by increased body weight, the highest median WHZ and median WAZ. Meanwhile, the combination of psychosocial stimulation and daily egg consumption in children have the greater effect on chronic nutritional improvement. This improvement is indicated by the highest increase in median PB body length and mean HAZ.
Nutrition plays a significant role in the development of children. Inadequate nutrition during early life will have major and long-term developmental consequences. The first 1000 days of life are defined as an individual life from the third trimester of pregnancy until the first two years. It is crucial time for individuals to fulfill their needs based on the stage of development and ensure the effectiveness of stimulation. However, children’s development in developing countries are often suboptimal. The suboptimal development of children in developing countries are influenced by several factors, such as severe chronic malnutrition, inadequate early stimulation, iodine deficiency, and iron deficiency anemia [10].
Many studies have investigated individual relationships between nutrition, nutritional status, stimulation, and mental development [11]. Previous studies revealed that children who received adequate nutrition had significantly higher developmental scores on the cognitive, language, and socio-emotional scales at 12 months of age than those who did not receive

intervention [12]. Moreover, at the age of 24 y, children who received intervention have significantly higher language scores than those who did not [12].

Previous nutritional interventions studies show the importance of food safety, recommended feeding practices, and increasing the nutritional density of complementary foods, including high-quality protein and energy densities [13]. The
high-quality protein is required to improve linear growth of children, especially in an area with high prevalence of inflammation and infection [13]. Linear growth is strongly influenced by high-quality protein intake through serum transthyretin, serum amino acids, and insulin-like growth factor-1 (IGF-1)[14]. Proteins and essential amino acids are necessary for the growth of children[15]. Recent evidence suggests that stunted children may not receive adequate essential amino acids and low circulating amino acids[16]. Insulin-like growth factor-I (IGF-I) is a protein hormone that mediates the effects of growth hormone and is reported to have multiple anabolic effects on skeletal muscle and other tissues [17]. When children have insufficient protein and essential amino acid intakes, serum transthyretin (TTR), serum amino acid (AAS) and low serum IGF-1 levels, the growth of children will be inhibited [16]. In addition, a study in Malawi, found that the levels of essential amino acids, lipids and choline were significantly lower in stunted children than in non-stunted children.[18].
Eggs are an excellent source of nutrients. Eggs holistically support the early growth and development of an organism and have a high nutrient content. Therefore, eggs have great potential to improve the nutrition of mother and child during the first 1,000 days of life[18]. Eggs provide great benefits since eggs have almost all essential micronutrients for babies' growth [19]. Moreover, eggs have an excellent nutritional profile as a nutrient-dense food that contains balanced nutrition. In addition, Eggs are easy to store, transport, clean, cook and eat, and can be served whole or as an ingredient in more complex recipes. Of all animal protein sources, eggs have one of the lowest environmental impacts, support physical and cognitive development and reduce malnutrition in children [18].
Eggs is known as a source of amino acids and essential fats, several minerals and vitamins and is an important element of the initial diet as a complementary food [19]. A medium egg has 78 kcal (324 kj) of energy, and daily egg consumption contribute to about 3% of the average energy requirement of an adult men and 4% for an adult women [19]. Furthermore, besides the high amount of essential micro and micronutrient, eggs also contain high amount of choline [20,21,22]. Choline is required for several critical pathways in growth and development, including conversion to acetylcholine, phosphatidylcholine, and sphingomyelin. This analysis focuses on the one-carbon metabolic cycle, including betaine, DMG, methionine, and vitamin B-12 [23,24].
Eggs are enriched with 3 essential fatty acids, a study conducted by Lanotti, L Lora., et al found that eggs significantly increased DHA plasma concentrations in the intervention group compared to the control group, with a relatively large effect size of 0.43[25]. It is widely established that DHA is essential in neurodevelopment and growth but rarely found in children's diet [26,27,28]. Hard-boiled eggs contain concentrations of DHA comparable to poultry (0.04 g/100 g), although higher than animal milk or beef, but less than fish such as herring (1.10 g/100 g)[28].
A study of the effects of egg consumption on women and children showed the child's growth, indicators were significantly improved with a diet that included eggs [18]. A study conducted in Iran to assess the relationship between egg consumption and physical growth

showed a significant growth increase among children in the intervention group who ate more eggs than those in the control group [29].

Another factor that influences toddlers' development is the stimulation of growth and development, including motor development. Many cognitive performances are influenced by the success of motoric development of the children [10]. Motor development is acknowledged as one of the most important developments of children to be monitored in childhood [10].

5. CONCLUSION

To sum up, our study suggested that psychosocial stimulation had the best effect on improving acute nutritional problems such as body weight, WHZ and WAZ. Either psychosocial stimulation or egg intervention had a significant impact on improving chronic nutrition. However, combining these interventions results in greater improvement of chronic malnutrition such as body length and HAZ.

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