MANAGEMENT OF STUNTING TO IMPROVED CHILDREN NUTRITIONAL STATUS AND COGNITIVE

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Abstract

Stunting defined as growth failure in childen under the age 5 years caused by chronic malnutrition thus children have low height-for-age. Stunting has a negative impact on the children later life, like disruption of brain development, cognitive development, growth faltering, and low immune system. Management stunting to improved nutritional status and cognitive is needed to reduce the negative impact of stunting on children. This review aims to identified management of stunting that might be possible improved children nutritional status and cognitive. Literature searching on 2 databases, Pubmed and Sciencedirect. Articles were systematically selected consistent to the topic of management stunting. Steps on writing the review were carried out in accordance with the PRISMA guidelines. 1012 articles identified from 2 databases, 15 articles that met inclusion criteria were included. Adding zinc to vitamin A, afford multiple micronutrient, and provide health education to mother increased children height and height-for-age. Provide omega-3 less effective to improved children cognitive. Management of stunting is important to prevent the negative impact of stunting to children, needs contributions from various related parties to overcome the problem of stunting. Provide health education and responsive stimulation to mother gradually can be the first step to improved children nutritional status and cognitive.

Keywords: stunting, vitamin A, micronutrient, health education.

1. INTRODUCTION

Stunting defined as growth failure on children under the age of 5 years caused by chronic malnutrition, thus children has low height-for-age. Stunted and severely stunted defined as children under the age of 5 years with inconsistent weight-for-age or height-for-age in accordance to WHO-MGRS (Multicentre Growth Reference Study) standard 2016 [1]. In 2011 stunting estimated contribute to 14% to 17% deaths among children under the age of 5 years [2]. Globally, in 2018 there were 149 million children under the age of 5 years were stunted, 49 million wasted, and 40 million children overweight [3].

Riskesdas (Basic Health Research Indonesia) 2018 showed prevalence of stunted and severely stunted in Indonesia is 30.8%, it is dropped from 37.2% (Basic Health Research 2013) [4]. Indonesia included in 17 from 117 countries that has high prevalence of stunting, wasting, and overweight in children under the age of 5 year [5]. Health profile of Special Region of Yogyakarta Province showed prevalence of stunted in children under the age of 5 years were 13.86% [4]. It is showed that prevention and management of stunting in Indonesia, especially Special Region of Yogyakarta Province not running optimally.

Research in 137 developing countries showed risk factors of stunting globally is low birth weight, poor sanitation, and diarrhea [6]. Risk factors of stunting on preschool children in Indonesia

is low household expenditure, low healthy eating index score, low maternal height, low maternal education, higher family member, low energy and protein adequacy level, older age, living in rural area, male sex, low sanitation score and higher phosphor and vitamin C adequacy level [7].

Stunting has both long-term and short-term consequences. Short-term consequences are disruptive of brain development, cognitive development, impaired physical growth, and metabolic disorder in the body. Long-term consequences are decreased cognitive abilities and learning achievement, low immune system thus children vulnerable to illness, high risk for diabetes, obesity, abnormalities of heart and blood vessel function, cancer, stroke, and disability in the old phase [8].

Study from Saleem et al (2014) shown that health and nutrition education (intervention group) decreased stunting 10% more than control group [9]. Review from Roberts (2017) shown that giving zinc, Vitamin A, and multiple micronutrient in the first 2 years of children life can decreased the incidence of stunting [10]. Giving vitamin A is more effective to improved children growth than giving vitamin A and zinc [11]. Study from de Jong et al (2012) shown that omega-3 is not effective to improved children cognitive and development [12]. This result is contrast with study from Makrides (2013) that consume omega-3 routinely can improve children development [13].

What kind of management that effective to improved nutritional status and cognitive on stunted children? This review aims to perceive management of stunting to improved children nutritional status and cognitive that can implemented in Indonesia, thus it can be considered by healthcare provider, government, and any related parties to give intervention in stunted children to reduce the negative impact on later life.

2. MATERIALS AND METHODS

Literature searching used 2 databases, Pubmed and Sciencedirect used relevant keyword that have been developed and used references list and specific websites. Literature searching limited to articles published in the last 10 years, English, original research (review were excluded), all countries were included, except countries with conflict and studies with children have chronic disease were excluded. Selection articles processes refer to the PRISMA guidelines [14]. The process of selection articles is illustrated in figure 1.

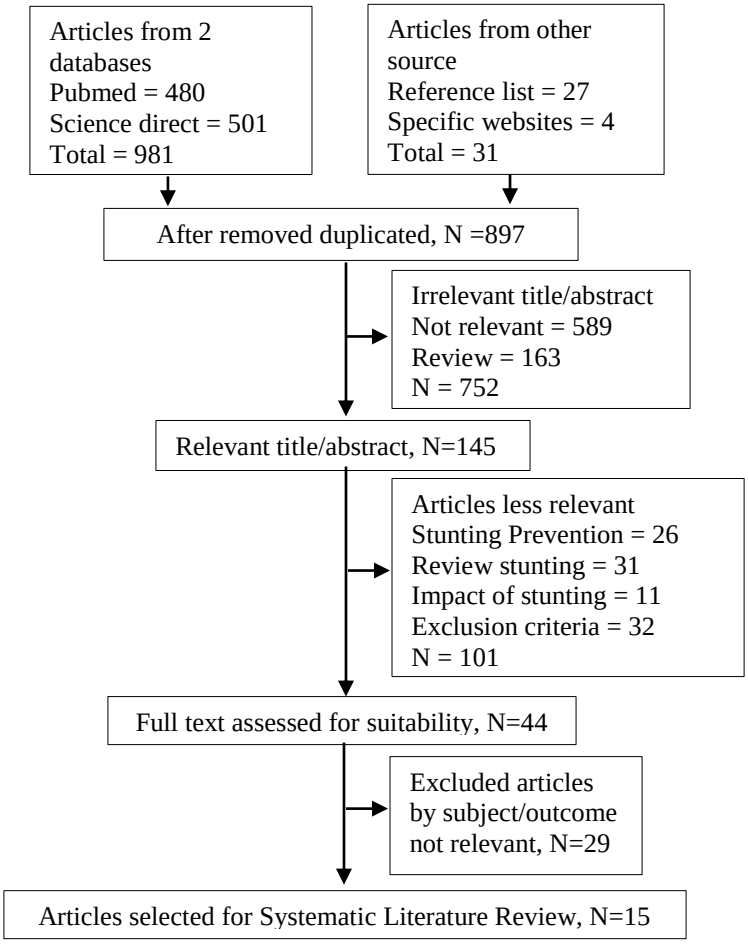

Figure 1. Process of selection articles

Data extraction have been done to understand specifically and grouping intervention into few point, like study site, methods, intervention and result or any finding from the studies. We grouping intervention or treatment into 4 point. 1) giving vitamin A 200.000 IU with zinc, 2) giving micronutrient with omega-3, 3) provide health education to mother (responsive stimulation, parenting, children food intake and diets, cooking etc.), 4) giving multiple micronutrient to children. Table 1 present data extraction from articles analyzed.

Table 1. Data extraction

Author	Country	Method	Participant	Intervention	Duration
Dalton et al. 2009 [15]	South Africa	RCT-single blind	183	Energy 684 kcal, carbohydrate 0.17 g, protein 6.68 g, total fat 14.95 g, ALA 335.02 mg, EPA 82.16 mg, DHA 191.66 mg, LA 1567.36 mg, AA 23.35 mg	6 month during the school days.
Vazir et al. 2012 [16]	India	RCT	600	Provide education of standard-care and complementary food, and responsive play.	1 year
Lebenthal et al. 2014 [17]	Israel	RCT	200	Energy 354 kcal, protein 24.5 g, carbohydrate 42.4 g, fat 10.2 g, calcium 350 mg, vitamin (A,C,D) and mineral (iron, zinc)- RDA % 16%-80%.	1 sachet/ day, 6 month
Mangani et al. 2015 [18]	Malawi	RCT	840	71 g/day corn-soy based micronutrient, 54 g/day milk-based micronutrient.	12 month
Muthayya et al. 2009 [19]	India	RCT	598	Vitamin A 500 µg, riboflavin 0.9 mg, Vitamin B6 1 mg, vitamin b12 1.8 µg, folate 300 µg, vitamin C 227.1 mg, calcium 231 mg, iodine 100 µg, iron 18 mg, zinc 10.5 mg, n-3 total 1.03 g, ALA 0.93 g, DHA 0.10 g.	6 day/ week for 12 month
Christian et al. 2015 [20]	Bangladesh	RCT	5536	Ready to eat food from rice, chickpea, and wheat-based and medium lipid-based nutrition.	Every day in 12 month
Yackobovitch-Gavan et al. 2016 [21]	Israel	RCT	129	Energy 354 kcal, protein 24.5 g, carbohydrate 42.4 g, fat 10.2 g, calcium 350 mg, vitamin (A,C,D) and mineral (iron, zinc)- RDA % 16%-80%.	1 sachet/ day for 6 month
Samuel et al. 2018 [22]	Ethiopia	Quasi-experimental	2309	Vitamin A 1332 IU, Vitamin D 200 IU, Vitamin E 5 mg TE, Vitamin B_1 0.5 mg, Vitamin B_2 0.5 mg, Vitamin B_6 0.5 mg, Vitamin B_{12} 0.9 mcg, Niacin amide 6 mg, Folate 150 mcg, Vitamin C 30 mg, Iron 6 mg, Zinc 4.1 mg, Copper 0.56 mg, Selenium 17 mcg, Iodine 90 mcg.	1 sachet/2 days for 9 month
Yousafzai et al. 2016 [23]	Pakistan	RCT	1302	Monthly visit which provide responsive stimulation education and complete nutrition.	4 years

Reifsnider et al. 2016 [24]	Arizona	Quasi-experimental	174	Education about nutrition, children behavior, parenting, and community resource.	1 year
Rockers et al. 2016 [25]	Zambia	RCT	268	Screening and referral for acute malnutrition and infection. Encouragement of the use of routine care services for children, immunizations, growth monitoring and vitamin A supplementation. Educate mother about cognitive stimulation, play practice, cooking practice and nutrition for children.	1/ 2 weeks for 1 year
Lien et al. 2009 [26]	Vietnam	RCT	454	Milk contain energy 75 kcal, protein 3.2 g, fat 3.0 g, carbohydrate 15.1 g, calcium 156 mg, phosphate 350 mg, sodium 46 mg, potassium 165 mg, magnesium 13 mg, iron 1.3 mg, zinc 1.1 mg, iodine 0.037 mg, manganese 0.26 mg, copper <0.1 mg, vitamin A 4.4 IU, D_3 0.70 IU, E 2.6 mg, B_1 0.12 mg, B_2 0.23 mg, C 33 mg.	6 day/week in 6 month
Sazawal et al. 2010 [27]	India	RCT	633	Milk contain zinc 7.8 mg, iron 9.6 mg, selenium 4.2 µg, copper 0.27 mg, Vitamin A 156 µg, vitamin C, 40.2 mg, vitamin E 7.5 mg.	3 sachet/ day for 12 month
Hess et al. 2015 [28]	Burkino-faso	RCT	2435	Energy 118 kcal, iron 6 mg and 20 other micronutrient. Different zinc content, 10 mg zinc and 5 mg zinc.	2 day in 9 month
Adriani and Wirjatmadi. 2014 [29]	Indonesia	RCT	24	Vitamin A supplementation 200,000 IU and zinc syrup 0.37 mg	6 day/ week in 6 month

3. RESULTS AND DISCUSSIONS

Vitamin A plus Zinc

The content of Vitamin A discussed is Vitamin A 200.000 IU. Study intervention multiple micronutrient with Vitamin A <1300 IU, thus exclude from this intervention category. In the intervention group each child received Vitamin A 200.000 IU with syrup containing 0.37 mg Zinc. The supplementation and placebo given 6 days/week for 6 month. Intervention group and control group have same characteristic data. Both of intervention group and control group have height-for-age -2SD in average, retinol serum 16 μ/dl, IGF-1 level 1, Zinc serum 22 μ/dl in the intervention group and 35 μ/dl in the control group. The average of z-score height-for-age increased in both group, but intervention group have higher increment that is 0.3±0.3 than control group (0.2±0.4). Zinc serum increased in both group, but the increment in the intervention group (43±23 μ/dl) was higher than in the control group (25±13 μ/dl) ($p<0.039$) [29].

Main function of zinc is essential for normal linear growth on children. Zinc also play important role in synthesis RNA and DNA. As part of dehydrogenase enzyme, zinc have a role in middle phase of metabolism, alcohol detoxification and vitamin A metabolism. Vitamin A has important role on growth, and deficiencies of vitamin A can lead to growth failure. Vitamin A supplementation linked with increment of growth by reduced infection and diarrhea on children, which is a growth inhibit factor [10]. Zinc related to metabolism of Vitamin A, its mean that zinc linked with several function of Vitamin A, thus zinc is needed in Vitamin A synthesis [30]. Finding of this review in line with the study by Chen et al in China, that increment of height and height-for-age was higher in the group that given intervention of Vitamin A with Zinc than control group ($p<0.05$) [31]. Study in Peri-urban Community in Mexico showed positive effect from giving Vitamin A and Zinc on child growth, used 2 different growth indicator [32]. Zinc and Vitamin are both antioxidants. There is a conspicuous relationship between Vitamin A and hematopoiesis, and increasing serum zinc can induce the release of Vitamin A from the liver to serum [31]. With Zinc help, absorption of Vitamin A is more optimal and concentration is higher.

Study in South Africa showed different outcome, increment of height-for-age was higher in the group with micronutrient than group with Vitamin A alone or Vitamin A with Zinc [33]. Other study took place in Purworejo showed supplementation of Vitamin A have more effect in child growth than supplementation of Vitamin A and Zinc or Zinc alone, but also not significantly affect child growth [34]. Study in South Africa showed different outcome can be affected by the type of intervention that given to children, the significant outcome was identified in micronutrient than Vitamin A and Zinc intervention.

Micronutrient with Omega-3

Two studies examined the effect of giving omega-3 on child growth and cognitive. One study giving omega-3 with micronutrient [19] and other study giving bread contain omega-3 [15]. The intervention group were given powder contain 900 mg ALA and 100 mg DHA and micronutrient [19]. The intervention group at other study were given bread from fish flour contain 335 mg ALA and 191 mg DHA [15]. The cognitive abilities and anthropometry measured before and after the study. Study by Muthayya et al (2009) showed omega-3 not significantly effect on child growth and cognitive, but the micronutrient have significant effect on child growth and cognitive. There was reduction of prevalence of stunting, wasting, and underweight. Cognitive abilities increased ($p<0.025$) [19]. There was positive relationship between DHA, omega-3, and cognitive abilities [15].

Docosahexaenoic acid (DHA) and arachidonic acid (AA) is essential for child growth and development. N-3 and N-6 LCPUFA (long chain polyunsaturated fatty acid) is essential for infant

and child brain development, including several neuron process [35]. There is high concentration of DHA in main nervous system, and accumulated in third trimester of pregnancy and the first 2 years in postpartum, the main source of DHA after birth is in the breast milk [36]. Laboratory experiment showed that n-3 LCPUFA can increased synaptic efficiency and neuroelectic transmission signal velocity, thus n-3 LCPUFA increased cognitive process through improvement of fastness of absorbing information [37]. In line with the study from Birch et al in Dallas and Kansas, there was significant relationship for height-for-age in children 1, 5, 4, and 6 months in the intervention group. Visual acuity poorer in 12 months children in control group than children given DHA supplementation [36]. Study of Baumgartner J et al (2015) DHA/EPA intervention increased weight-for-age, but not affect cognitive, memory ability, and long-term memory on children [38]. Social-economy, culture, and country may affect the difference of the result.

Health Education on Mother

Four studies identified giving intervention with provide education to mother with stunted children. Intervention provided was home-visit and community-based education program. One study provided education on child health [24], 3 studies add responsive stimulation on the intervention group [16], [23], [25]. Four studies showed different result. Study in Zambia, giving intervention with provide health education and responsive stimulation increased weight-for-age 0.12 SD, height-for-age 0.15 SD, and there was reduction of stunting. Increment of motoric function and cognitive on children was 0.11 SD [25]. Mother who attend 5-8 times of gathering have increment on child growth than those who attend 0-4 times of gathering ($p=0.026$) [24]. Intervention which provide responsive stimulation showed the average of children IQ score was higher than those who not given responsive stimulation ($p<0.05$) [23]. There was significant difference the prevalence of stunting between intervention group that given education about food intake (36%), education about food intake and responsive stimulation group (28%), and control group (37%) [16].

Giving education about nutrition and responsive stimulation to mother can increase mother knowledge about type of food needed by children and motivated mother to give appropriate care and stimulation to support children growth. Provide education to mother has a positive impact on parenting behavior for children growth, including child nutrition and interaction between the children and caregiver [25]. Four study about giving education on mother showed that education about nutrition and responsive stimulation increased children growth and nutritional status. Giving education about appropriate food intake in the intervention group had bigger weight, height, and arm circumference average than in the control group [9]. Study from Nair et al has different outcome, there was no significant difference between intervention group and control group on height-for-age [39]. The intervention less effective on mother who has stress, children with low intake of Vitamin C, iron, and zinc [24].

Multiple Micronutrient Supplementation

Intervention of giving multiple micronutrient on children was done in several developing countries, there is 8 of 15 studies identified giving multiple micronutrient intervention. The average of duration giving intervention is was 9-12 months, children age between 6 month old to 9 years old. Two studies used milk with adding micronutrient as intervention group and giving regular milk to control group [26], [27]. Two other studies the intervention group was given multiple micronutrient, and low micronutrient on control group [17], [21]. While 4 other studies didn't give anything on control group [18], [20], [22], [28]. Studies that giving milk intervention showed reduction of stunting and underweight incidence for 10% [26]. There was increment of weight 0.21

kg/year (p<0.001) and height 0.51cm/year (p<0.001) [27]. Studies that giving low dosage of micronutrient on control group showed significant increment of weight and height on the intervention group (p<0.001 and p=0.005) [17]. There was increment of height 0.19±0.14 SD after the intervention continued for 12 months [21]. In the end of the study the average of height-for-age was higher in the intervention group compared with the control group (p<0.005), increment incidence of stunting was smaller in the intervention group (+17.7%) than in the control group (+29.0%) [22]. Children that given micronutrient mixture have higher increment of height and height-for-age than children in the control group (p=0.029) [18]. In the 18 months follow up, the prevalence of stunting was 39.9% in the intervention group and 29.3% in the control group (p<0.0001) [28].

The growth of the human body requires many different micronutrient supply. Proteins, lipid, and carbohydrate provide "building materials" and energy, other micronutrient and mineral play regulatory role. In other word, with adequate nutrition supplementation (that provide calories, mineral and vitamin) added to children daily intake possibly can increase children growth [17]. Finding of this review in line with the study from Chen et al that micronutrient intake has significant effect to cognition [40]. On 24 months old, intervention group has higher height-for-age than control group significantly, the prevalence of stunting decreased in the intervention group at 18 months [41]. Milk consist of growth-like hormone including insulin and other biologic active substance who play the micronutrient distribution role. Contrast with the study by Sazawal et al (2014) giving sprinkles/powder of micronutrient on children in the age of 6-24 months didn't show difference between intervention group and control group [42]. Giving micronutrient sprinkles/powder every each day didn't affect children growth, but showed an effect to iron status and anemia on children [43]. WHO recommend fortification of food sprinkles/powder with iron (micronutrient) to children in the population with anemia more than 20% [22].

4. CONCLUSION

Management of stunting that effective to improve child growth and cognition is giving vitamin A with adding of zinc, giving multiple micronutrient, and giving health education about nutrition and responsive stimulation on mother with stunted children. The effectiveness of giving omega-3 to improve growth and cognition in less known because between omega-3 and micronutrient, micronutrient has higher effect. From the result of this review the government can proposed program to reduce stunting, it can start with giving education about health and nutrition routinely to mother and can start giving the children not only vitamin A but also zinc in the same time, because the current program is only giving Vitamin A to children.

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