7. What explains stunting among children living in a rice surplus area in Central Java, Indonesia?

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Abstract

Demak district is part of the province of Central Java, one of the national rice stock areas in Indonesia. In 2013, in Central Java the districts ranked sixth in rice productivity, but, at the same time, seventh in chronic child malnutrition. This paradox triggered an interest in the correlations between food accessibility and utilisation of households in Demak and the prevalence of stunting among children under five years old. During December 2014-February 2015, this issue was investigated in three sub-districts in Demak that had the highest rice production and poorest nutritional status of children under five. The oldest breastfed children aged 6 to 60 months from farmer families were selected for food intake and nutritional status measurement. Data were obtained on household socio-economic status, general characteristics, anthropometry, and food intake of the children. Nearly one-third (31.9%) of the 335 children in the study was stunted. Remarkably, food accessibility was similar between households with and without stunted children. However, diet quality regarding energy, calcium and iron intake was significantly better in households without stunted children. Unhealthy snacking habits of the children were found to contribute to an inadequate food intake as well. Improvement of complementary foods and family diet, including healthy homemade snacks based on locally available foods from animal and plant sources should be promoted.

Keywords: expenditure, income, stunting, diet

7.1 Introduction

Food and nutrition security indicates a situation in which at all times adequate food is available and accessible in terms of quantity, quality, safety and socio-cultural acceptability, and the food can be satisfactorily utilised by individuals for an active and healthy life (Weingärtner, 2005). This description includes the four pillars of food security, i.e. availability, accessibility and utilisation, as three physical aspects, and stability as the time dimension. The last part of the description refers to nutrition security (cf. Gross *et al.,* 2000).

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Food availability is achieved when adequate food is available, from either domestic production or imports. Access to food at the household level, means ensuring that households have sufficient resources for getting adequate nutritious foods through production, purchase or donation. Utilisation of food is accomplished through nutritious and safe diets, an adequate biological and social environment, and proper health care. In the term food utilisation, the aspects of food and non-food items (health) are included. The aspect of stability takes into account the availability and accessibility of food through time, also during lean periods. The four pillars of food and nutrition security are finally manifested in the nutritional status of the individual household members (FAO, 2006; Gartaula *et al.,* 2017; Maxwell and Smith, 1992).

There is an increasing interest among government and non-government organisations in the question whether interventions in agriculture have the potential to improve the nutritional situation of the beneficiaries. Several systematic reviews showed that increased agricultural production does not automatically result in an improved nutritional status of the farmer family members concerned (Berti *et al.,* 2004; Leroy and Frongillo, 2007; Masset *et al.,* 2011, 2012; Ruel, 2001).

In Indonesia, rice is considered the most important staple food. Since more than three decades, the agricultural policies of the national government prioritise increasing rice production through subsidies, infrastructure interventions, monitoring, etc. Following the achievement of rice self-sufficiency in 1984, the national government started to focus on diversifying food crops (Five Year Plan 1989-1994), with the intention to increase employment opportunities and intensify poverty alleviation. However, the progress was slow and up to now there have been no clear guidelines for implementation. Rice continued to be the most important food crop, especially after by the global economic crisis in 1997-98 (Asian Development Bank, 2006; Thomas, 2003). Prioritising rice cultivation was considered to be the best option for the farmers because of a definite market and farmer experiences in producing rice, especially if the farm capital was a major constraint (Purwestri *et al.,* 2017; Siregar and Suryadi, 2006).

In 2013, the Central Bureau of Statistics reported that Central Java province ranked as the second highest national rice producing area (BPS, 2014). However, this high productivity was not reflected in the nutritional status of children living in this area. The district of Demak in Central Java had the sixth highest rice production within this province. However, in the same year, the Indonesian Ministry of Health (MoH, 2013a) reported that the prevalence of stunted children in Demak was above 30%, indicating an alarmingly high prevalence of chronic malnutrition in this area. The 2010 Ministry of Health report also stated that farmers were considered a vulnerable group due to their monthly expenses being in of the lowest quintile of the distribution and having the highest prevalence of stunted children (MoH, 2010).

Recognizing the complex relationship between agricultural production and nutritional status, this study investigated the contribution of household expenditure and dietary intake to the nutritional status of children below five years old from farmer families living in a rice surplus area with a high prevalence of stunted children. Figure 7.1 shows the conceptual framework of the study.

Figure 7.1 was developed based on UNICEF (1998), Gross *et al.* (2000) and Masset *et al.* (2011). The framework shows agricultural production's impact on food accessibility, as indicated by the economic situation and dietary diversity of the family. The provided and consumed foods and breastmilk intake can be converted into macro- and micronutrient intake, which determines the nutritional status of the children below five years of age. Care plays an important role in the nutritional status of children through feeding practices as well as hygiene behaviour, sanitation and health care utilisation. The figure shows the interrelationships.

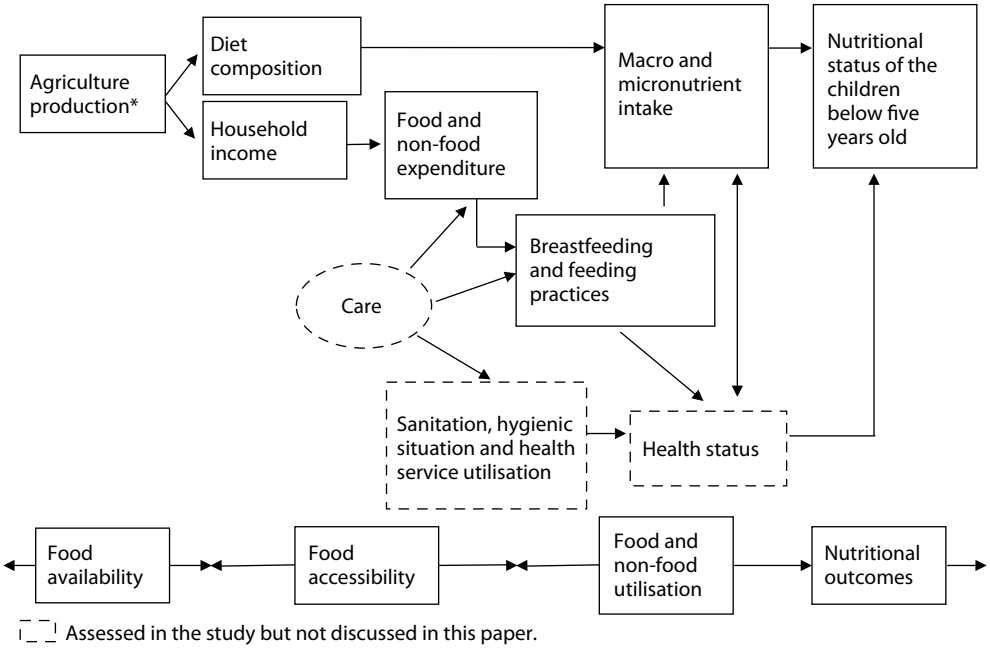

*Figure 7.1. Conceptual framework of the study. * = discussed in detail by Purwestri et al. (2017).*

7.2 Methodology

A cross sectional survey was conducted by the first author in the period December 2014-February 2015, in Demak district, Central Java, Indonesia. Of the 35 districts in Central Java, Demak had the sixth highest rice productivity in 2013 of 6,117 kg per hectare and in 2012 the seventh highest percentage of child underweight (indicated by weight-for-age Z-score <-2SD) of 9.4% (Purwestri *et al.*, 2017). In the same period, the prevalence of stunted children (height-for-age z-score <-2 SD of the reference population) in Central Java was above 30% (MoH, 2013a). Nutritional status based on height-for-age (HAZ) scores of Indonesian children at province level is usually reported by the Ministry of Health as part of a regular national health and nutrition survey. Since children's height is not commonly measured during the monthly growth monitoring carried out by voluntary workers at the integrated health services posts, called *posyandu*, at the village level, Central Java province only reported incidence of underweight based on the WAZ scores of the children. In Demak, the three sub-districts of Karanganyar, Dempet, and Gajah, were selected for the research because they had a high rice productivity and poor nutritional status of children under five. In total, eight villages in Karanganyar, seven villages in Dempet and one village in Gajah were identified as rice surplus areas and were then chosen as sites for data collection.

The oldest non-exclusively breastfed children under five years (aged between 6 and 60 months) living in farmer households were selected to capture as much as possible stunting in children. Stunting reaches its highest level between 18 and 24 months, often as a consequence of inadequate complementary feeding (Gross *et al.*, 1996; Seth *et al.*, 2011). Farmers in the study included farmers with land, tenant farmers, farm workers, sharecroppers and livestock raisers. Lists of eligible children in the selected villages in Karanganyar, Dempet and Gajah were obtained from village midwives or *posyandu* workers to establish the proportions of children, and then draw up a random sample of eligible children (Purwestri *et al.*, 2017).

A structured questionnaire was used for data collection. Mothers of the eligible children were interviewed at home and were asked about the child's general characteristics and household expenditure. Data on the dietary intake of the children was collected by a 24-hour food intake recall, including frequency and estimated duration of breastfeeding. The children's height was measured using a height/length board depending on the age of the children, and their weight was determined using a SECA 201 scale. Two focus group discussions (FGDs) were conducted in Karangwaru Kidul village and Dempet village in the sub-districts of Karanganyar and Dempet, respectively, to gather information regarding food habits of children under five years of age. FGD respondents (about six to maximum ten women per FGD) were selected based on lists provided by village midwives or voluntary health workers of the *posyandu*. In addition, in-depth interviews with two midwives and one nutritionist at the local health centre were carried out.

7.2.1 Sample size

A minimum sample size of 330 children was deemed necessary for a cross-sectional study in the area having a stunting prevalence of 31.1% in Central Java (MoH, 2013a) with a confidence level of 95% and a power of 0.8. In addition, for detecting differences between the group of stunted versus non-stunted children, a minimum of 95 children per group was calculated (Lwanga and Lemeshow, 1991). The final sample size needed for this study was 335 eligible children.

7.2.2 Data analysis

An analysis was performed, testing the relationship of agricultural production and revenue, dietary intake and HAZ-score of the 335 respondents. Data was checked for compliance with a normal distribution using QQ-plots of normality. For normally distributed data, differences in means were tested with the Independent T-test, while for the non-normally distributed data the Mann-Whitney U-test was used. Statistical analysis was performed using IBM SPSS Statistics Version 22. Anthropometric data were transformed to Z-scores using Emergency Nutrition Assessment version 2011 (ENA for SMART). Two groups of children were categorized based on HAZ-score; below -2SD was defined as stunted, while a HAZ-score ≥ -2 SD was considered non-stunted. Data from one day 24-hour recall food intake of the children was converted into macro- and micronutrient intake using Nutrisurvey. Breastmilk intake was estimated using Butte *et al.* (2002) reference data. In the analysis, snacks, either homemade or bought from nearby shops or street vendors, which were consumed by the children were separately assessed for their contribution to the children's diet. Nutrition intake was compared to the guidelines of nutrient intake for Indonesian well-nourished children (MoH, 2013b). FGDs and in-depth interviews data on dietary habits were transcribed, evaluated and coded. The important keywords were listed and grouped in Microsoft Excel. Total household expenditure was calculated based on monthly (routine) and yearly (non-routine) expenditures, and used as the indicator of food accessibility per month. Household expenditure per capita was divided into food- and non-food items expenses per month. Cost of snacks as part of food expenditures was reported separately. For more details on site selection, sampling and quality control of the study the reader is referred to Purwestri *et al.* (2017).

7.2.3 Ethical approval and informed consent

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, University of Brawijaya, Malang, Indonesia. Informed consent was obtained from all

individual participants included in the study who volunteered to join the research. The informants in the in-depth interviews also gave the permission to record their statements.

7.3 Results

The total sample of this study comprised of 335 children aged above six months and below five years. Of the total sample, 107 children were stunted (31.9%), the other 228 (68.1%) were categorized as non-stunted children, and 62% of the children were still breastfed on the day of the survey (59.8% and 62.3% of stunted and non-stunted children, respectively). As already reported by Purwestri *et al.* (2017), stunted children were significantly older, lighter and shorter (34.3±13.0 months, 10.6±2.1 kg, 83.4±7.9 cm, respectively) than non-stunted children (29.9±15.3 months, 11.3±2.9 kg, 86.5±10.7 cm, respectively), irrespective of their sex.

No stunted children were found in the youngest age group of 6 to 12 months. However, the prevalence of HAZ-score below -2SD increased strikingly after the age of one year (35.8% for children aged 12 to 36 months and by 36.1% for children aged 36 to 60 months). Of the 50 stunted children aged between 12 and 36 months, 18 (10.9%) suffered from severe stunting (HAZ-score below -3SD). A similar proportion (9.8%) of severe stunting was found among the group of children above three years of age. Table 7.1 shows the characteristics of the children per age group. It is striking to see that nearly 29% of the children were still breastfed at the age of three to five years, indicating that prolonged breastfeeding is a well-established practice in the study area. Additionally, 10.1% of the children in the sample were wasted, 3.3% of them severely so. When the children were grouped according to

Table 7.1. Characteristics of the study children according to age groups.[1]

Characteristics	Age groups		
	≥6 to <12 months n=37	≥12 to <36 months n=165	≥36 to <60 months n=133
Child's sex (girls)	43.2 (16)	46.1 (76)	48.9 (65)
Breastfeeding (yes)	91.9 (34)[c]	81.2 (134)[c]	28.6 (38)[a,b]
Child's age (months)	9.4±1.7[b,c]	23.8±6.9[a,c]	46.7±6.8[a,b]
Child's height (cm)	71.1±2.9[b,c]	81.2±5.9[a,c]	95.1±5.5[a,b]
Child's weight (kg)	7.8±1.0[c]	10.0±1.5[a,c]	13.4±2.3[a,b]

[1] Data is presented as % (n) or mean ± sd.

[2] Group comparisons were analysed using Chi's square test (categorical data) or ANOVA continued by LSD test (continuous and normally distributed data). [a,b,c] Values followed by the same letters are not significantly different at $P<0.001$.

breastfeeding status, the prevalence of the children having HAZ and WHZ-score below <-2SD was similar among breastfed and non-breastfed children.

Both groups of children were from similar socio-demographic backgrounds as indicated by housing type, house ownership, parental occupation, and educational level (Purwestri *et al.*, 2017). They also had similar household size (median: 4, minimum: 3 and maximum: 9). Table 7.2 shows the economic indicators of stunted and non-stunted children in the study area. It was found that the prevalence of stunting of children was similar across the household's total yearly farm income (wealth) quintiles per capita. Likewise, the indicators of monthly household expenditure (total, food- and non-food items expenses) of the stunted and non-stunted children were not statistically different. In addition, snacks cost contributed to 68.3 and 57.6% of the total monthly food cost for stunted and non-stunted children.

The contribution of breastmilk, complementary foods/home-based meals, and snacks in the dietary intake of stunted and non-stunted children is presented in Figure 7.2. Overall, dietary intake fulfilment of non-stunted children was better than that of the stunted ones. Fulfilment of energy, calcium and iron intake from home-based family diet of non-stunted children was significantly higher than stunted children (P<0.05), and the other fulfilment of nutrients (protein, vitamin B6 and vitamin A intake) of non-stunted children was

Table 7.2. Economic indicators of stunted and non-stunted children.[1]

Socio-economic indicators	Non-stunted children n=228	Stunted children n=107	*P* value[3]
Wealth quintiles per capita per year			0.853
Lowest	20.6 (47)	19.6 (21)	
Second	19.3 (44)	21.5 (23)	
Middle	18.9 (43)	22.4 (24)	
Forth	20.2 (46)	19.6 (21)	
Highest	21.1 (48)	16.8 (18)	
Monthly household expenditure per capita per month (in €)[2]			
Non-food items	24.9 (16.0; 37.8)	23.7 (13.8; 34.6)	0.220
Food items	10.6 (8.1; 14.5)	10.6 (7.4; 14.7)	0.529
Snacks	4.9 (3.2; 6.6)	4.9 (3.2; 7.9)	0.372
Total	37.7 (25.8; 55.3)	33.6 (26.5; 49.3)	0.196

[1] Data is presented as % (n) or median (25^{th}, 75^{th} percentiles).
[2] Exchange rate during data collection: €1 = Rp15,240.
[3] Group comparisons was analysed using chi-square test (categorical data) or Mann-Whitney test (continuous and not normally distributed data).

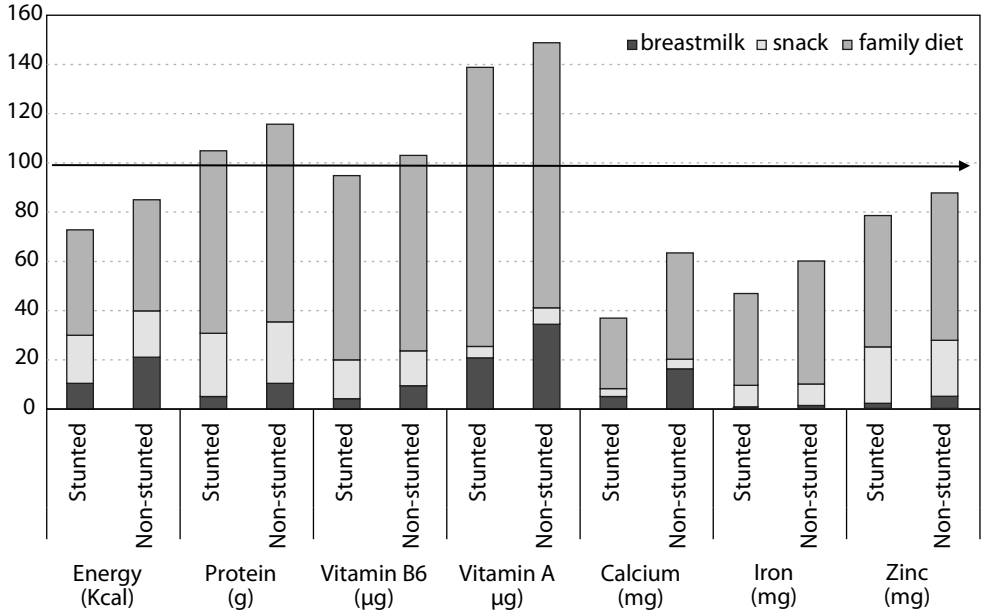

Figure 7.2. Contribution of breastmilk, snacks and complementary feeding/family diet to the total daily habitual intake of stunted and non-stunted children.

slightly higher compared to the stunted counterparts. Protein and vitamin A intake of both categories of children exceeded the Indonesian dietary recommendation for well-nourished children; however, intake of selected minerals (calcium, iron and zinc) did not reach the 100% dietary intake fulfilment. In addition, vitamin B6 intake of non-stunted children also surpassed the dietary guidelines for Indonesian children. The contribution from breastmilk to dietary intake fulfilment of selected macro- and micronutrients intake of non-stunted children was significantly higher than that of stunted children ($P<0.001$). On the other hand, contribution of snacks to the fulfilment of selected macro- and micronutrient intake of stunted and non-stunted children did not differ significantly.

The contribution of snacks as a source of nutrients also increased with increasing age. Snacks contributed 9.7, 21.0, and 19.4% to the total daily energy intake of children in the age groups ≥6 to <12 months, ≥12 to <36 months, and ≥36 to <60 months, respectively, based on the recommended intake of well-nourished Indonesian children. In total, 94.4% of stunted children consumed snacks at the time of the survey, a significantly higher proportion than that of 88.7% of the non-stunted ones ($P=0.01$).

In total, 15 mothers (7 in Karanganyar and 8 in Dempet sub-district) participated in the focus group discussions. The mothers reported that rice was the main staple food for the

child's meal. Meal frequency per day was two to three times depending on age of the child. Based on the family financial situation, the most commonly side dishes offered were fried-egg, tofu, *tempeh* (fermented soya), and catfish (fresh water fish) with spinach clear ('*sayur bayam bening*') or carrot-cabbage soup. The mothers also reported a high consumption of snacks bought from the nearby shop or street vendors, which made their children consume these snacks at the expense of eating the offered family meals, saying that if their children cried for the snacks they would try to buy and give the foods, even during the lean season.

7.4 Discussion and conclusion

The contradictive situation of child malnutrition in a rice-surplus area motivated us to investigate specific factors that could contribute to the high prevalence of stunting among children in the study area of Demak, Central Java. In Indonesia, rice is the staple in the typical local diet. A hundred grams of white rice contains 366 kcal energy, but provides only 1 mg of iron, 0.63 mg of zinc and no vitamin A (Jati *et al.*, 2012). Additionally, Sekiyama *et al.* (2012) reported that high consumption of snacks among Indonesian children in another Java province limited the intake of adequate nutritious food among children. These findings triggered our interest to analyse the relationships between food accessibility, dietary intake and stunting among children in Demak. Purwestri *et al.* (2017) reported that both groups of non-stunted and stunted children in the study area were from similar socio-economic background. The stunting prevalence in the whole sample of children was high (31.9%). From 335 households, 66 did not have any agricultural production in the previous year. However, at the time of the survey, all of the respondents had at least one family member who earned some revenue from on-farm activities as a farm worker. The other 269 households (80.3%) had between one to four types of agricultural production (crops and/or livestock) (Purwestri *et al.*, 2017).

Masset *et al.* (2011) presented a trajectory of household income from agricultural production, through household expenditure (including food expenses), to food intake and nutritional status. However, for our study area, Purwestri *et al.* (2017) reported that the income of households with non-stunted children was only slightly higher than that of households with stunted children. When the family per capita income was categorised into wealth quintiles, the proportions of stunted children were similar across all quintiles. In the same vein, monthly expenditure per capita on food and non-food items of households with non-stunted children was slightly, but not significantly, higher than that of households with stunted children. Hence, it can be concluded that the conditions in terms of food availability and accessibility are more or less the same for stunted and non-stunted children. The only difference was that households with non-stunted children significantly spent more money on yearly non-routine health care activities and improved environmental living conditions than households with stunted children (Purwestri *et al.*, 2017).

The first 1000 days of an infant's life (from the first day of pregnancy until 2 years of age) constitute a critical window of opportunity for growth and development. During this period, inadequate dietary intake, frequent infections, and unfavourable environmental conditions may lead to short- and long-term health consequences and poor nutritional status among children (Black *et al.,* 2008; Rosado, 1999; Semba *et al.,* 2008; Stephensen, 1999; Victora *et al,.* 2008*,* 2010). Stunting starts mostly at the age of six months, when the first complementary food is commonly introduced, and can continue up to older ages (Gross *et al.,* 1998; Seth *et al.,* 2011). In the study area, there were no stunted children in the age group of 6 to 12 months, but the prevalence of children with HAZ-score below -2SD increased significantly after the age of 12 months by 35.8% for children aged 12 to 36 months and by 36.1% for children aged 36 to 60 months.

Figure 7.2 shows that breastmilk contributed to dietary quality. It protects the children from being stunted by decreasing the fulfilment gap of energy, vitamin B6, calcium, zinc and iron intake. Even, the bioavailability of lactoferrin in breastmilk is the highest (>50%) compared to heme iron (15-30%) and non-heme iron (<5%) (Halberg, 1981; Saarinen *et al.,* 1977). The composition of human milk is unique, dynamically and actively adapting to the individual infant's nutritional needs, and modifying with prematurity and postnatal age (Scherbaum and Srour, 2016). Breastmilk provides all the needed macro- and micronutrients and fulfils the recommended dietary allowance for infants under six months of age (Lubetzky *et al.,* 2013). After the age of six months, however, complementary food with adequate macro- and micronutrients should be introduced (WHO, 2003), while breastmilk remains the main source of energy and nutrients for infants and young children. Approximately, 50% and 30% of an infant's energy intake is provided by breast milk within the first year and the second year of life, respectively. Moreover, breast milk has long been recognized to provide high-quality nutrients and protection against infectious diseases (Sankar *et al.,* 2015; WHO, 2003). Several studies pointed out that mothers are more likely to breastfeed stunted, wasted or underweight children for a longer period of time compared to healthy children. This so-called inverse infant feeding causality leads to the wrong assumption that prolonged breastfeeding impairs growth (Simondon and Simondon, 1998). In this study, like Giugliani *et al.* (2015) in their study, we found no significant relationship between breastfeeding practices and stunting prevalence.

In the study area, the family diet consumed by the non-stunted children was significantly better in percent fulfilment of energy, calcium and iron intake than that of stunted children, although calcium, iron and zinc intake were still below the level of the Indonesian dietary guidelines for both stunted and non-stunted children. It is likely that better food choices for the children were found among families with non-stunted children, however, the fulfilment gap of the selected mineral intake from both categories of households indicate the need of improving the diet quality of home-based foods in general.

Children's diets should consist of a variety of foods from animal and plant sources. Iron, zinc, and vitamin A are more readily available in animal sources, while several vitamins like B and C are present in foods that are plant-based. A balanced diet is an important health indicator especially for young children (Gibson, 2005; Murphy and Allen, 2003). In Indonesia, home-based meals are characterized as a rice-based diet with mainly plant sources rather than animal sources of protein and a moderate intake of fruits (Jati *et al.*, 2012). Furthermore, Santika *et al.* (2009) and Fahmida (2013) reported an increased consumption of fortified factory-produced, ready-to-use complementary foods among Indonesian children. By use of these products the micronutrient content of complementary food offered to children could be enhanced (Santika *et al.*, 2009). However, these ready-to-use baby foods often increase the risk of childhood obesity and other related chronic degenerative diseases mainly because of preservative agents and a high sugar content (Barness, 1993; Bentley, 2014).

We also found a high snack consumption, especially by older children. Snacks that are either homemade or bought from nearby shops or street vendors were introduced after the child was able to consume something other than breastmilk. Typically, different types of snacks that can be bought outside of home are offered to children such as ready-to-eat snack foods, fried snack foods (e.g. tofu, *tempeh*, and bananas), meatballs (*bakso*), and soft drinks, including homogenised milk and fruit drinks. Unfortunately, we discovered that the children often consume these snacks instead of taking their meals. The monotonous rice-based diet combined with high consumption of snacks seemed to contribute to low HAZ-scores of children. Snacks have a high energy content, but are often low in micronutrient content (Sekiyama *et al.*, 2012). During the focus group discussions, it transpired that the mothers did not fully understand the consequences of frequent consumption of these snacks for their children. They would often give in to the children's demand for snacks, instead of persuading the children to consume homemade food. Snacks could be bought for a relatively low price ranging from Rp 500 to Rp 10,000 (€0.03 to €0.66). A significantly higher proportion of stunted children (94.4%) consumed more snacks per day than non-stunted children (88.7%).

The households appeared to spend more than half of their monthly food budget on snacks. This food choice in food expenditures is problematic, also because the hygienic conditions of food sold by the street vendors is questionable. Previous studies in Indonesia regarding food purchase from street vendors found poor hand-washing practices and direct hand contact with foods, thus increasing the risk of food-borne diseases. (Gasem *et al.*, 2001; Vollaard *et al.*, 2004).

In this study, the food availability and accessibility (as indicated by farm income and expenditure per capita) of households with stunted children were similar to those of non-stunted children, indicating that these factors do not explain the high prevalence of stunting. However, non-stunted children had a lower snack intake and were provided with a significantly better home-based diet quality than stunted children. Furthermore, the

study showed that breastmilk intake protected non-stunted children by decreasing the gap between selected daily nutrient intake and recommended intake. Thus, improving health and nutrition knowledge and practices of mothers regarding the benefits of breastfeeding and appropriate complementary feeding, as well as the promotion of healthy homemade diets and discouragement of snacks, seem to be crucial in supporting families to making healthier food and feeding choices.

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