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Double burden malnutrition of preschool children and its association with brain development and milk consumption: A case study in Bogor, West Java, Indonesia

Dissertation for the acquisition of the academic degree
Doctor of Agricultural Sciences (Dr. agr.)

Submitted to the Faculty of Organic Agricultural Sciences
of the University of Kassel

by
Eny Palupi

Witzenhausen, February 2015

Double burden malnutrition of preschool children and its association with brain development and milk consumption: A case study in Bogor, West Java, Indonesia

This work has been accepted by the Faculty of Organic Agricultural Sciences of the University of Kassel as a dissertation acquiring the academic degree of Doktor der Agrarwissenschaft (Dr. agr.)

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Disputation date	: 17th February 2015

Double burden malnutrition of preschool children and its association with brain development and milk consumption: A case study in Bogor, West Java, Indonesia

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Abstract

Background: Protecting the quality of children growth and development becomes a supreme qualification for the betterment of a nation. Double burden child malnutrition is emerging worldwide which might have a strong influence to the quality of child brain development and could not be paid-off on later life. Milk places a notable portion during the infancy and childhood. Thus, the deep insight on milk consumption pattern might explain the phenomenon of double burden child malnutrition correlated to the cognitive impairments.

Objective: Current study is intended (1) to examine the current face of Indonesian double burden child malnutrition: a case study in Bogor, West Java, Indonesia, (2) to investigate the association of this phenomenon with child brain development, and (3) to examine the contribution of socioeconomic status and milk consumption on this phenomenon so that able to formulate some possible solutions to encounter this problem.

Design: A cross-sectional study using a structured coded questionnaire was conducted among 387 children age 5-6 years old and their parents from 8 areas in Bogor, West-Java, Indonesia on November 2012 to December 2013, to record some socioeconomic status, anthropometric measurements, and history of breast feeding. Diet and probability of milk intake was assessed by two 24 h dietary recalls and food frequency questionnaire (FFQ). Usual daily milk intake was calculated using Multiple Source Method (MSM). Some brain development indicators (IQ, EQ, learning, and memory ability) using Projective Multi-phase Orientation method was also executed to learn the correlation between double burden child malnutrition and some brain development indicator.

Results and conclusions: A small picture of child double burden malnutrition is shown in Bogor, West Java, Indonesia, where prevalence of Severe Acute Malnutrition (SAM) is 27.1%, Moderate Acute Malnutrition (MAM) is 24.9%, and overnutrition is 7.7%. This phenomenon proves to impair the child brain development. The malnourished children, both under- and over- nourished children have significantly (P-value<0.05) lower memory ability compared to the normal children (memory score, N; SAM = 45.2, 60; MAM = 48.5, 61; overweight = 48.4, 43; obesity = 47.9, 60; normal = 52.4, 163). The plausible reasons behind these evidences are the lack of nutrient intake during the sprout growth period on undernourished children or increasing adiposity on overnourished children might influence the growth of hippocampus area which responsible to the memory ability. Either undernutrition or overnutrition, the preventive action on this problem is preferable to avoid ongoing cognitive performance loss of the next generation. Some possible solutions for this phenomenon are promoting breast feeding initiation and exclusive breast feeding practices for infants, supporting the consumption of a normal portion of milk (250 to 500 ml per day) for children, and breaking the chain of poverty by socioeconomic improvement. And, the national food security becomes the fundamental point for the betterment of the next. In the global context, the causes of under- and over-nutrition have to be opposed through integrated and systemic approaches for a better quality of the next generation of human beings.

Acknowledgements: This study was financially supported by Faculty for the Future program from Schlumberger Foundation.

Keywords: Double burden malnutrition, brain development, milk consumption, Indonesian children.

Doppelbürde von Fehlernährung von Vorschulkindern im Zusammenhang mit ihrer Gehirnentwicklung und deren Milchkonsum: eine Fallstudie in Bogor, West Java, Indonesien

von Eny Palupi

Kurzfassung

*Hintergrund: Die S*icherung des Wachstums von Kindern und ihrer Entwicklung ist als oberstes Ziel für die Entwicklung einer Nation anzusehen. Fehlernährung von Kindern kann einen sehr starken Einfluss auf die Qualität der Gehirnentwicklung und somit auf die Entwicklung im späteren Leben haben, was auch später nicht mehr ausgeglichen werden kann. Die Doppelbürde von Fehlernährung von Kindern entsteht weltweit, Milch trägt dazu einen deutlichen Teil während des Säuglingsalters und der Kindheit bei. Deshalb könnte ein tieferer Einblick in das Milchkonsummuster das Phänomen der Doppelbürde von Fehlernährung von Kindern im Zusammenhang mit kognitiven Beeinträchtigungen aufklären.

Zielsetzung: Die aktuelle Studie soll (1) den aktuellen Stand der indonesischen Doppelbürde von Fehlernährung von Kindern beurteilen: eine Fallstudie in Bogor, West Java, Indonesien, (2) den Zusammenhang dieses Phänomens mit Gehirnentwicklung von Kindern untersuchen, und (3) den Beitrag des sozioökonomischen Status und der Milchkonsum zum diesen Phänomen beurteilen damit eventuelle Lösungen formuliert werden können, um das Problem zu beheben.

Gestaltung: Die Querschnittsuntersuchung mittels eines strukturierten kodierten Fragebogens wurde unter 387 Kindern im Alter 5-6 Jahren und deren Eltern aus 8 Gebieten in Bogor, West-Java, Indonesien vom November 2012 bis Dezember 2013 durchgeführt um sozioökonomischer Status, anthropometrische Messungen und Geschichte des Stillens zu dokumentieren. Ernährung und Wahrscheinlichkeit der Milchannahme wurden mittels zwei 24-stündigen Nahrungsrückrufs sowie eines Lebensmittels Frequenz Fragebogens beurteilt. Gewöhnliche tägliche Milchannahmen wurde mit der Mehrfachquellensmethode (Multiple Source Method) berechnet. Einige Indikatoren der Gehirnentwicklung (IQ, EQ, Lernen und Gedächtnisleistung) wurden nach dem Verfahren des Projektiven Mehrstufigen Orientierung Methode abgearbeitet um den Zusammenhang zwischen Doppelbürde von Fehlernährung von Kindern und einzelnen Indikatoren der Gehirnentwicklung herauszufinden.

Ergebnisse und Fazit: In Bogor, West Java, Indonesien wurde ein kleines Bild der Doppelbürde von Fehlernährung von Kindern dargestellt, wo die Prävalenz der schweren akuten Unterernährung (SAU) beträgt 27,1%, leichten akuten Unterernährung (LAU) – 24,9% und Überernährung – 7,7%. Dieses Phänomen scheint nachweislich die Gehirnentwicklung von Kindern zu beeinträchtigen. Fehlernährte Kinder – sowohl unter- als auch überernährte – haben eine wesentlich geringere (P-Wert<0.05) Gedächtnisleistung im Vergleich zu den normalen Kindern (Gedächtnisnote, N; SAU = 45.2, 60; MAU = 48.5, 61; Übergewicht = 48.4, 43; Adipositas = 47.9, 60; Normal = 52.4, 163). Die einleuchtende Gründe für diese Beweise sind dass Mangel an Nährstoffaufnahme während der Wachstumsperiode in unterernährten Kindern oder zunehmende Fettleibigkeit in überernährten Kindern den Zuwachs des für die Gedächtnisleistung zuständigen Hippocampusareals beeinflussen könnte. Egal ob es sich um Unterernährung oder Überernährung handelt, sind die Vorbeugemaßnahme für dieses Problem vorzuziehen um den laufenden Verlust der kognitiven Leistungsfähigkeit der nächsten Generation zu vermeiden. Zu einigen möglichen Lösungen dieses Phänomens gehören die Förderung der Initiierung des Stillens und des Verfahrens des ausschließlichen Stillens für die Säuglinge, Förderung des Konsums einer normalen Portion Milch (250 bis 500 ml pro Tag) für Kinder, und Unterbrechung der Armutskette durch Verbesserung der sozioökonomischen Bedingungen. Und die nationale Ernährungssicherheit wird als ein Kernpunkt für die Verbesserung in der Zukunft anzusehen. In einem globalen Kontext müssen die Gründe der Unter- und Überernährung durch integriertes und

systematisches Vorgehen entgegengetreten werden für die bessere Qualität der nächsten Generation von Menschen.

Danksagung: Diese Studie wurde von dem Fachbereich für das zukünftige Programm der Schlumberger Stiftung finanziell unterstützt.

Stichwörter: Doppelbürde von Fehlernährung, Gehirnentwicklung, Milchkonsum, indonesische Kinder.

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Declaration

Hereby I declare that this work, submitted to University of Kassel, Germany, for the award of degree of Doctor of Agricultural Sciences (Dr. agr.) in the Department of Organic Food Quality and Food Culture, Faculty of Organic Agricultural Sciences, University of Kassel is the result of original work carried out by myself under the guidance of Prof. Dr. Angelika Ploeger and Prof. Ir. Ahmad Sulaeman, MS, Ph.D. I further give assurance that I completed this dissertation independently without prohibited assistance of third parties or aids other than those identified in this disseration. All passage that are drawn from published or unpublished writings, either word-for-word or in paraphrase, have been clearly identified as such. Third parties were not involved in the drafting of the material content of this dissertation; most specifically I did not employ the assistance of a dissertation advisor. No part of this thesis has been used in another doctoral or tenure process.

Witzenhausen, February 2015

Eny Palupi

Contents

List of abbreviations

BMI : Body Mass Index (calculated as kg/m^2)
BMIfAz : BMI-for-Age z-score
BPS : Badan Pusat Statistik (the national statistical office)
CDC : Centers for Disease Control and Prevention
DRI : Dietary Reference Intake
EQ : Emotional Quotient
FAO : Food and Agriculture Organization
FFQ : Food Frequency Questionnaire
h : hour
HKI : Hellen Keller National
IDR : Indonesian Rupiah rates
IQ : Intelligence Quotient
IYCF : Infant and Young Child Feeding
MAM : Moderate Acute Malnutrition
MDG : Millenium Development Goal
MSM : Multiple Source Method
N : Number of respondent
na : the information is not available
NCHS : National Centre for Health Statistics
NNR : Naturally Nutrient Rich
NSS : Nutrition Surveillance System
PMPO : Projective Multi-phase Orientation method
Posyandu : Pusat Pelayanan Terpadu (integrated service post)
P-value : calculated probability, estimated probability of rejecting the null hypothesis
SAM : Severe Acute Malnutrition
SES : Social Economic Status
UNICEF : United Nations Children's Fund
USD : United Stated Dollar
WfAz : Weight-for-Age z-score
WHO : World Health Organization
y : year
z-score : a standard score indicated the relative position to the mean

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Abstract

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1 Introduction

1.1 Background

There are four facts described in the following sections which are supporting the reason why the current study on “Double burden malnutrition of preschool children and its association with brain development and milk consumption: A case study in Bogor, West Java, Indonesia” is undertaken and important. Those facts are about the value of children for society, the adverse impact of child malnutrition, the current state of the world child nutritional status, and the milk as apart of child feeding practices.

1.1.1 Value of children for society

Children are the precious assets of the universe (Behera 2005: 65). They are the next successors who will lead the world. A future national thrive highly depend on the status of the children. The quality of their growth and development sets the next quality of their nation. Fail to assist the children into their bright future means fail to assist the nation into its improvement (UNICEF 2000: 3). Depriving their childhood means depriving their nation to excel due to the loss of the best future actors of the nation. Therefore, ensuring their optimal growth and development is a must (Behera 2005: 65).

1.1.2 Adverse impact of child malnutrition

A good nutrition, environment, and education are the imperative needs of children to grow and develop properly (UNICEF 2009: 2). Properly means that the children are on “a state of a complete physical, mental, and social well-being” (WHO 2003: 100). All of these aspects are equally important and might influence each other. Therefore it is very urgent to assess all of those aspects to guide their optimal growth and development. However, it is not easy to assess all of them together since it should merge many major fields and involve many expertises. Current study focuses on the nutrition during early human life which might influence the optimal growth of children which then might interfere their later health status. This is known as “early nutrition programming” (Koletzko et al. 2009: 1).

Childhood is the most sensitive period toward the nutrition intake quality and quantity. Childhood is the period in which the human is growing fastly. Studies reported that the improper nutrient intake during the first five years of life may influence the brain growth which is not possible to be paid-off on the next period of life (Thompson and Nelson 2001: 8; Besty and Georgieff 2006: 158; Strain et al. 2008: 776; Wainwright 1992: 193). A normal growth child – in the terms of a child with adequate nutrient intake – will achieve 80% of his adult brain weight in their first 2 years, and achieve 90% in their first 5 years (Dekaban and Sadowsky 1978: 355; Lenroot and Giedd 2006: 720).

Similar to the rest of the body, the brain is constructed from protein, fat, carbohydrate, vitamins and minerals which are essentially supplied by the diet. Since brain grows faster than the rest of the body, a dietary interruption during a critical stage of development may result in lasting changes in brain structure and function (Benton 2010a: 457). Therefore, malnutrition especially for under-five children threatens the quality of the next life, not only for their own life, but also the quality of the next generation as a cumulative society (WHO 2003; Dekaban and Sadowsky 1978: 355).

1.1.3 Current state of the world child nutritional status

Nevertheless, current state of the world children indicates a miserable fact. More than 2.5 million children, equivalent to 1 in every 22 children, die every year due to world hunger (FAO et al. 2012: 4; UNICEF 2007: 11). UNICEF together with WHO and World Bank (2014: 2) reported that on the global scale, in 2013, as many as 99 million children under-five, or 15%, were underweight. As many as 161 million children under-five, or 25%, were stunted. And as many as 51 million children under-five, or 3%, were wasting who live under the risk of severe acute malnutrition (SAM) and death (UNICEF et al. 2014: 1). These have left many generations with irreversible physical and mental disabilities (Black et al. 2011: S64). Even though its world pattern is decreasing, but the prevalence still high and remains the top world problem.

Current state of Indonesian children is also viewing a miserable reality. In 2010, as many as 3.9 million of Indonesian children were underweight, 7.76 million were stunting, and 2.9 million were wasting. When these figures were converted into percentage from total under-five children population in Indonesia, about 17.9%, 35.7%, and 13.3% of them were underweight, stunting, and wasting, respectively (Riskesdas 2010: 29ff). The prevalence of underweight and stunting were increasing in 2013, i.e. about 19.6% and 37.2%, respectively.

The previous figure is higher than the prevalence of the world children and still far from the MDG 1 target. Stevens et al. (2012: 824) reported that prevalence of child undernutrition was quite high especially in 141 developing countries, including Indonesia, i.e. 19.4% in 2010. The chance of these countries was estimated less than 5% to meet MDG1 target, i.e. halving the prevalence of children Weight-for-Age z-score less than -2 between 1990 and 2015 or prevalence of child undernutrition less than 2.3% (Stevens et al. 2012: 824).

However, eventhough it is very urgent to assess the nutritional quality of food intake of Indonesian children for better future, but the related and comprehensive study about "early nutrition programming" (Koletzko et al. 2009: 1) from Indonesia is limited.

1.1.4 Milk as apart of child feeding practices

All factors which might disturb the process along the fetal development (maternal diet, smoking or alcohol use), infancy (breast or bottle feeding) and childhood (feeding practices, children diet, passive exposure of tobacco smoke, physical and social environment) might influence the total performance of the children (Smith et al. 2009: 2).

Assessing under-five children diet provides abroad spectrum of diet. Among their diet, milk places a notable portion. Until 6 months of human life, breast milk is the best intake that most recommended. In some reasonable condition, infant formula could be an alternative. After 6 months of age, it is recommended to introduce a complementary food while the breast milk is fed till 2 years of age or beyond (WHO 2003). Hereafter, milk is still recommended to be a part of children diet to support their optimal growth (Koletzko 2014). Milk is recommended since it is categorized as a nutrient-dense food which provides a lot of nutrients for the body with relatively low energy content (Steijns 2008: 426). And it has ability to provide those condensed nutrients in such a wonderful balance emulsion which is easily available and absorbable in human body (Steijns 2008: 426).

Moreover, beyond those wonderful potential abilities of milk in supporting the optimal growth of Indonesian children, Indonesia faces a hard international trade situation. A gap between domestic milk -supply and -demand induces a high dependency of Indonesia to the imported cow milk powder (AC Nielsen 2012: 56). Milk skimmed dry was one of top 25 imported commodities in 2010 (FAOSTAT 2013). Thus, milk becomes one of executive foodstuffs in Indonesia.

As an illustration, the minimum salary level in West Java – Indonesia was about 200 USD/month in 2013 (BPS 2014: 1) while the average price of milk is about 2 USD/L (Own data). Therefore, roughly the Indonesian parents have to spend 60 USD/month or 30% of salary with assumption every child follows recommendation of 2 portion of milk/day or about 500ml/day and have 2 children/family. This 30% of salary for milk is quite large compared to the average expenditure for the total food, i.e. about 46% (Own data). Therefore, it is very interesting and important to examine the milk consumption pattern correlated to the double burden child malnutrition and cognitive performance in Indonesia.

1.2 Aim and objectives

The present thesis aims to study the relationship between early nutrition and brain development by using three main indicators, i.e. nutritional status, cognitive development, and milk consumption pattern through a case study conducted in Bogor, West Java, Indonesia. Bogor is selected since this area is included on the list of NSS area[1]. Further, this city is considered as a place where the people who live in consists of quite diverse ethnical groups across Indonesia due to a large number of immigrant population, so that might reflect Indonesian culture. Bogor also has many research centres which then enable an ease technical work of the study.

Specifically, there are three objectives of the current study: (1) to characterize the current face of Indonesian child nutritional status: a case study in Bogor, West Java, Indonesia; (2) to assess the correlation between the phenomenon of double burden child malnutrition and cognitive performance, and explore the plausible reason behind this correlation, and (3) to evaluate the correlation between phenomenon of double burden child malnutrition and some observed factors then analyse the possible solution to encounter this problem. The expected outcome of this study is to give a scientific pilot-suggestion in solving toddler's malnutrition in Indonesia and to support a healthy brain development of the Indonesian next generation.

To support the current study, the next chapter (2) provides some overviews about double burden malnutrition, brain development, milk consumption pattern, and profile of Bogor, West Java, Indonesia. Subsequently, the research hyphotesis and the detailed methodology are briefly described in Chapter 3. Thereafter, Chapter 4 is attempted to

[1] Nutrition Surveillance System area (NSS) is “a large population-based nutritional surveillance database of urban and rural families in Indonesia”. NSS is established by Ministry of Health, Government of Indonesia, and Hellen Keller International in 1995, based on the framework of UNICEF about the causes of malnutrition (Semba et al. 2008: 438).

present the overall analysis results of the study. Following these chapters, the comprehensive discussions about the results are presented in Chapter 5. The discussions consist of three main issues, those are: current profile of Indonesian child malnutrition, correlation of double burden child malnutrition and cognitive development, and exploration on affecting factors and possible solutions for these phenomenon. And finally some conclusions are stated in Chapter 6.

2 Theoretical background

Apart of the theoretical background (Chapter 2) has been published on Palupi E, Sulaeman A, Ploeger A. 2013. World hunger, malnutrition and brain development of children. In: *Future of Food: Journal on Food, Agriculture and Society*, Vol. 1 (2), p. 46 – 56.

There are some important issues need to be discussed before further study about "Double burden malnutrition of preschool children and its association with brain development and milk consumption: A case study in Bogor, West Java, Indonesia". The following section (2.1) will briefly introduce about double burden malnutrition, followed by the explanation about the process of brain development (2.2). Subsequently, milk consumption pattern of children will be introduced on section 2.3. Then the last sub-section (2.4) will describe the general profile of Bogor, West Java, Indonesia.

2.1 Double burden malnutrition

In order to comprehend about the double burden malnutrition, some specific discussion related on this topic are going to be briefly presented in the following subsection, those are the definition of double burden malnutrition (2.1.1), the tools for assessing the child nutritional status (2.1.2), the current state of the world child malnutrition (2.1.3), and the current state of Indonesian child malnutrition (2.1.4).

2.1.1 Definition

Malnutrition is an inappropriate health condition as a result of imbalance nutrient intake and the body need within a period of time (UNICEF 2006a; WHO and UNICEF 2007). This term may refer to both undernutrition – if the intake is insufficient, and overnutrition – if the intake is excessive (UNICEF 2006a). Undernutrition also might be as a result of repeated infectious diseases which then influence the nutrient intake to the body (UNICEF 2006b). If those dual malnutrition coexist among the people at the same period of time then it is so called as the phenomenon of "double burden malnutrition" (Delisle 2008: 172). This phenomenon could be examined by assessing the nutritional status among the people (WHO 2008). Nutritional status is defined as "the internal state of an individual as it relates to the availability and utilization of nutrients at the cellular level" (Myatt et al. 2002: S10).

2.1.2 Tools for assessing child nutritional status

There are some growth standards available for assessing the nutritional status of children. These include the 2000 Centers for Disease Control and Prevention (CDC) growth charts, the 2007 World Health Organization (WHO) growth charts, and the National Center for Health Statistics (NCHS) growth references (Maqbool 2008: 5; Vesel et al. 2010: 39). The best reference is the reference which enables to give early alert when the malnutrition occurs (Maqbool 2008: 5; de Onis 2006: 942). Vesel et al. (2010: 46) has assessed the sensitivity of those references then they concluded that WHO reference give better sensitivity to measure child malnutrition than other references.

WHO provides a chart reference to measure nutritional quality of children, both under 5 years old and 5 to 19 years old. These references are bounded into WHO reference 2007 (WHO 2014). Nutritional status of under-five children could be evaluated using some parameters, those are length/height-for-age, Weight-for-Age, weight-for-height/length, body mass index-for-age (BMI-for-Age), head circumference-for-age, arm circumference-for-age, subscapular skinfold-for-age, and triceps skinfold-for-age (WHO 2013). For children more than 5 years old, nutritional status could be assessed by using three parameters; those are height-for-age, Weight-for-Age, and BMI-for-Age (WHO 2014).

Mainly, there are five types of children malnutrition. Those are underweight, stunting, wasting, overweight, and obesity. Underweight is a condition in which the weight below normal or Weight-for-Age below -2 SD. Stunting is a condition in which the height below normal or height for age z-score below -2 SD. Wasting is a state in which the ratio weight to height below normal or weight for height below -2 SD. While, overweight and obesity is a state in which the weight for height above +2SD from normal standard. All of these types are best applicable for children age below five years old (WHO 2013).

According to UNICEF 2013 and WHO 2013, the assessment of wasting and stunting for preschool children (age 5 to 6 years old) is best to be assessed by considering Body Mass Index for age (BMIfA) and using the WHO reference 2007 as the standard. BMI is a simple indicator of proportion of weight-for-height which is calculated as the weight in kilograms divided by the square of the height in metres (kg/m^2) (WHO 2006). Here are the guidelines for the cut-offs, i.e. (1) overweight if BMIfA z-score > +1SD and < +2SD, this is equivalent to BMI 25 kg/m^2 for age 19 years; (2) obesity if BMIfA z-score > +2SD, this is equivalent to BMI 30 kg/m^2 for age 19 years; (3) moderate acute

malnutrition (MAM) if BMIfA z-score < -2SD; and (4) severe acute malnutrition (SAM) if BMIfA z-score < -3SD. There are no agreed cut-offs using MUAC to assess wasting for this age. Height for age (HfA) indicator is used by applying the following cut-off points: moderate stunting if HfA z-score > -3SD and < -2SD and category severe stunting if HfA z-score < -3SD (UNICEF 2013: 6; WHO 2013).

However, Javed et al. (2014: 9) examined that BMI has high specifity but less sensitivity (73%) to evaluate the excessive body fat on children. More than a quarter of the obese respondents missed to be labelled as obese (Javed et al. 2014: 4). BMI calculation was based on body weight instead of body composition, while the obesity was determined as unbalanced body status due to the excessive of body fat which highly associated with some degenerative diseases (Javed et al. 2014: 9). However, from this study, it was indicated that if the child was diagnosed as obese by using BMI indicator means that the child definitely is obese (Javed et al. 2014: 8). But the children with normal BMI could be already suffer of excess adiposity (Javed et al. 2014: 8). BMI can be used to diagnose the obesity on young children till their adolescents 18 years old but not for below 2 years of age (Javed et al. 2014: 2). Therefore, the identification of overnourished children age 5 to 6 years old was better be done by using BMI instead of other parameters.

2.1.3 Current state of the world child nutritional status

UNICEF together with WHO and World Bank (2014: 2) reported that on the global scale, as many as 161 million children under-five, or 25%, were stunted in 2013. About half of them lived in Asia and over one third in Africa in 2013 (UNICEF et al. 2014: 2). Trend shows a reduction pattern, that is 36% decrease from 253 million in 1990. However, stunting is still a major public health problem in Africa and Asia, even it often occurs as a hidden malnutrition. Most African and Asian are stunting (UNICEF et al. 2012: 1). As many as 99 million the world children under-five, or 15%, were underweight in 2013 (UNICEF et al. 2014: 2). The trend of being underweight was also reduced 36% from 159 million in 1990. However many children are living under wasting risk (UNICEF et al. 2014: 2). It was reported that in 2013, as many as 51 million children under-five, or 8%, were wasting. This was a 11% reduction since 1990 (UNICEF et al. 2014: 2). Most of them (about 70%) coming from Asia who live under the risk of severe acute malnutrition (SAM) and death (UNICEF et al. 2014: 2).

At the same time, there has been the emergence of other types of malnutrition, i.e. overweight and obesity (weight above normal) as a result of long term overnutrition.

The prevalence of obesity among children and children being overweight is rising in many regions (UNICEF et al. 2014: 2). It was estimated that 42 million children under-five, or 7%, were overweight and obesity in 2013 (UNICEF et al. 2014: 2). The global trend is increasing sharply, about 54% from 28 million in 1990. Surprisingly, this phenomenon occurred not only in developed countries, but also in many developing countries. Obesity is found almost all over the world (UNICEF et al. 2012: 1). The prevalence in 2011 was 7% in Africa (12 million) and 5% in Asia (17 million) (UNICEF et al. 2012: 1). The overnutrition prevalence increased from 1% to 19% in Southern Africa, and from 3% to 7% in Southeastern Asia from 2000 to 2013 (UNICEF et al. 2014: 2).

The above fact presents the respective double burden of malnutrition, i.e. undernutrition and overnutrition together has become the current phenomenon. More than 25% of the world children live undernutrition, in which they grow up with many risk of impairment, discapabilities and morbidities which then will reduce the quality of the next generation (UNICEF et al. 2014: 2). It will leave many generations less productive than they would have been. Even though its pattern is decreasing, its prevalence still remains high and remains a top world problem. With the undernutrition problem remaining unsolved, the overnutrition problem emerged, not only among children but also mothers and adults (UNICEF et al. 2014: 2). Figure 2.1 illustrates the decreasing pattern of the prevalence of stunting and underweight among children under-five. It also shows the increasing pattern of prevalence of overweight and obesity among children under-five.

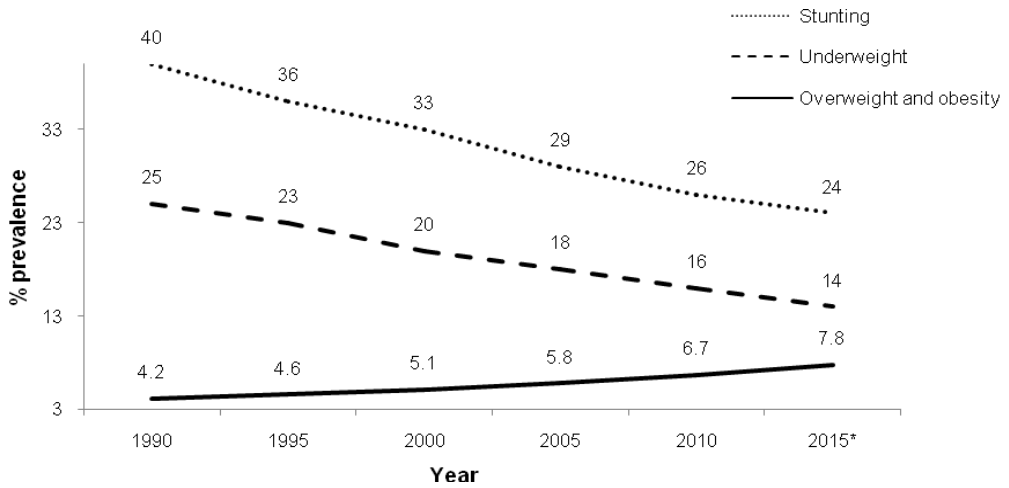


Figure 2.1 Prevalence of stunting, underweight, and overweight and obesity among children under-five years old on the global scale, 1990-2015

Source: Adapted and redrawn from UNICEF et al. 2012: 11; UNICEF et al. 2014: 2; and de Onis et al., 2010: 1260
Note: *Estimation number

It was estimated that 1000 million people worldwide were suffering from overweight and obesity, and 300 million people suffering from obesity (Steinfeld et al. 2006: 271). Surveys in 2008 showed that prevalence of obesity in Europe was 22% (Perez-Cueto et al. 2010: 156). In Australia in 2003, 60% of adults were overweight or obese, which the rate in 2008 was 2.5 times higher than in 1980 (Dunn et al. 2008: 331). A study in USA in 2000 reported that 2 of 3 US adults were overweight or obese (Glanz et al. 1998: 1118). The increasing trend alarms the world. Overnutrition might cause many chronic diseases, like cardio-vascular disease, diabetes, and certain types of cancer (Steinfeld et al. 2006: 269; McAfee et al. 2010: 1). However, childhood obesity is very important to be monitored. This type of childhood malnutrition is associated with serious health problems and the risk of premature illness and death later in life (de Onis et al. 2010: 1257). The respective double burden of malnutrition, both under- and overnutrition, is the current world problem and needs to be solved.

2.1.4 Current state of Indonesian children

In 2007, Indonesia was one of 76 developing countries which made insufficient progress to reach the Millennium Development Goal targets (MDGs) on Average annual rate of reduction (AARR) in the under-five mortality rate (UNICEF 2007: 7). Indonesia faces quite a severe problem on the children's health (Berger et al. 2008: 371; Campbell et al. 2008: 2244; Semba et al. 2008: 438; Semba et al. 2009: 387). Statistics showed that more than 26% children in Indonesia have suffered of malnutrition in 1998 to 2005 (BPS 2011, see Figure 1.3).

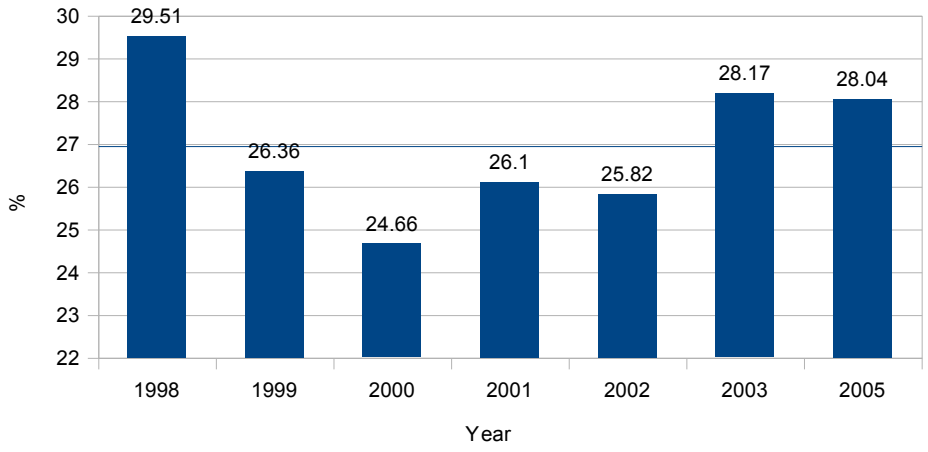


Figure 2.2 Percentage of moderately and severely undernutrition children age 0-5 years in Indonesia, 1998-2005

Source: BPS (The national statistical office of Indonesia) 2011

Stevens et al. (2012: 824) reported that prevalence of child undernutrition was quite high especially in 141 developing countries, including Indonesia, i.e. 19.4% in 2010. The chance of these countries was estimated less than 5% to meet MDG1 target, i.e. halving the prevalence of children Weight-for-Age z-score less than -2 SD between 1990 and 2015 (Stevens et al. 2012: 824). In 2010, as many as 3.9 million of Indonesian children were underweight, 7.76 million were stunting, and 2.9 million were wasting. When these figures are converted into percentage from total under-five children population in Indonesia, about 17.9%, 35.7%, and 13.3% of them were underweight, stunting, and wasting, respectively (Riskesdas 2010: 29ff). The most current figure views that the prevalence of children undernutrion in Indonesia still very high. Riskesdas (2013: 5) reported that the prevalence of Indonesian under-five children malnutrition in 2013 were 19.6% underweight, 37.2% stunting, and 12.1% wasting. This figure is still far from the MDG 1 target.

Studies reported that poverty is the main suspected reason behind this evidence, followed by low education level, especially the education of mother, unhealthy life style like smoking, hygiene, and diseases (Atmarita, Directorate of Community Nutrition, Indonesian Health Ministry 2005: 11ff; Israr et al. 2009: 2f). There is a strong evidence that economic crises increase the risk of malnutrition by reducing the household purchasing power (Sari et al. 2011: 195sff; Campbell et al. 2008: 2244).

In order to continuously monitor the nutritional status of the people throughout the country, including the children nutritional status, Indonesia has developed the so called Nutrition Surveillance System area (NSS), i.e. “a large population-based nutritional surveillance database of urban and rural families in Indonesia” (Semba et al. 2008: 439). NSS is established by Ministry of Health, Government of Indonesia, and Hellen Keller International (HKI) in 1995. HKI is a non profit organization founded by Hellen Adams Keller and George Kessler in 1915 which is devoted to research in vision, health and nutrition (HKI 2014). The establishment is based on the framework of UNICEF about the causes of malnutrition (Semba et al. 2008: 438). This NSS area included 5 major urban poor populations from slum areas in the cities of Jakarta, Surabaya, Makassar, Semarang, and Padang and the rural population from the provinces of West Sumatra, Lampung, Banten, West Java, Central Java, East Java, the island of Lombok (West Nusa Tenggara), and South Sulawesi (Semba et al. 2008: 439).

2.2 Brain development

Adequate nutrition intake is crucial for human health and development. Better nutrition is correlated to better life, both physically and mentally (WHO 2003). Along the period of life, childhood is the most sensitive period toward the nutrition insult. Childhood is the period in which the human is growing and developing. Studies reported that the life quality of children age 0 – 5 years old – especially the food and the environment is very much influencing their development. Insufficient nutrient intake and in-proper care during the first five years of life may influence the brain development which is not possible to be paid-off on the next period of life (Thompson and Nelson 2001: 8; Besty and Georgieff 2006: 158; Strain et al. 2008: 776; Wainwright 1992: 193). The following paragraphs present the process of human brain development in normal child.

A normal child – a child with adequate nutrient intake – will achieve 80% of his adult brain weight in their first 2 years, and achieve 90% in their first 5 years (Dekaban and Sadowsky 1978: 355; Lenroot and Giedd 2006: 720). Similar to the rest of the body, the brain is constructed from protein, fat, carbohydrate, vitamins and minerals which are essentially supplied by the diet. Since brain develops faster than the rest of the body, a dietary deficiency (due to hunger or undernutrition) during a critical stage of development may result in lasting changes in brain structure and function (Benton 2010a: 457). Therefore, undernutrition especially for under-five children threatens the quality of the next life, not only for their own life, but also the quality of the next generation as a cumulative society (WHO 2003; Dekaban and Sadowsky 1978: 355).

Thompson and Nelson (2001: 8) gave a best illustration regarding the developmental of human brain along human life (Figure 2.3). Brain development starts one month after conception, when the brain and spinal cord were formed within the embryo, this process is called neurulation (Thompson and Nelson 2001: 8; Thompson 2001: 28; Ulmer et al. 2013: 615). Then the cell continues to migrate. Almost all neurons were formed at the sixth gestation month. During this stage as many as 250 thousand neurons were generated per minute which then quickly migrate to the brain region where they will function (Thompson 2001: 28).

The neurons then differentiate to place a specialised roles and form synapses to connect with the other neurons for communication and store information. This process is called as synaptogenesis which starts 3 months before birth and continues throughout childhood. Georgieff (2007: 614S) mentioned that this gestation period is very vulnerable to nutritional insults due to the rapid trajectory of synapse formation

and myelination. By the moment of birth, the major neurons were appropriately located within immature brain and it has begun to function like mature brain (Thompson and Nelson 2001: 8; Thompson 2001: 28).

Significant changes and development of brain would be expected after birth. Synaptogenesis occurs particularly in the visual system and hippocampus (Georgieff and Innis 2005: 99R). The formation and induction of synapses, which makes neurons, communicate with other neurons, and continuously develop during this stage. This proliferation makes the brain more functioning and "connected" (Thompson 2001: 28). On the young brain these connections make the brain to much crowded. Therefore along the stimulation and learning process, some connections are reduced to make the system more efficient. This process is similar to the motto "use it or loose it"[2]. Connections which are not activated are then progressively reduced. Along total human life, the neurogenesis formation and synapses formation might occur, depending on the human experience (Thompson 2001: 29).

However the brain formation and neuron formation and initiation only occur during the early life development. During this formation, the brain needs adequately good quality nutrition as a raw material (Thompson 2001: 29). Nutrients are required in specific metabolic pathways and structural components (Georgieff 2007: 6146). Therefore, insufficient nutrition and stimulation during this stage might impair the brain development process which could not be paid-off on the later life. Georgieff (2007: 6145) mentioned that there are certain nutrients that have greater effects on brain development than others have. Those nutrients are protein, energy, certain fats, iron, zinc, copper, iodine, selenium, vitamin A, choline and folate.

Insufficient nutrition during early life might influence the brain development. Early life period is very susceptible to nutrient deficiencies (Georgieff and Innis 2005: 99R). Georgieff (2007: 6145) briefly explained how this deficiency can influence brain development. Protein-energy, iron, and zinc malnutrition all affect the development of hippocampus and cortex (Georgieff 2007: 6146). Hippocampus together with amigdala and prefontal cortex is essential for memory processes and emotions (Shin et al. 2006: 70). Hippocampus is one of the earliest areas to show cortical-cortical connectivity and functionality (Georgieff 2007: 6146). Nutrient deficiency in the early stages can affect differentiation in this area which influences the cells numbers and complexity, which then affect the functionality (Georgieff 2007: 6146).

2 "Use it or lose it" is a slogan by Slow Food® to protect endangered products by promoting people to consume them so that might save biodiversity from on going lose.

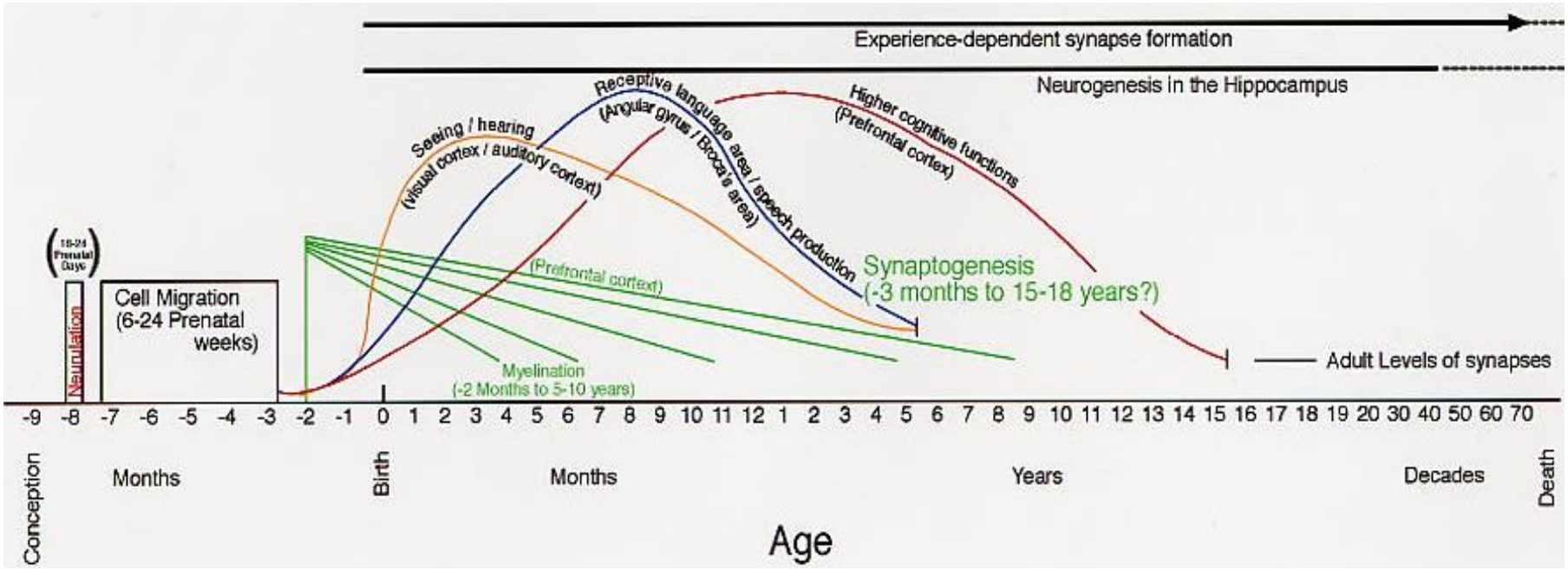


Figure 2.3 Human brain development along the human life

Source: Thompson and Nelson (2001: 8)

2.3 Milk consumption pattern

Adequate nutrition intake for infant and young child is very urgent for supporting their physical growth and mental development. Impairment during this early period evidently has life-longed consequence on human life, i.e. poor school performance, reduced productivity, and impaired intellectual and social development (WHO and UNICEF 2003: V). And it also might induce some non-communicable diseases in later life, such as obesity, hypertension, diabetes, heart diseases, etc. (Koletzko et al. 2009: V).

Recent international recommendations provide some feeding guidelines to support a healthy development of a normal new born infant, namely Infant- and Young Child Feeding (IYCF) practices (WHO and UNICEF 2003: V). Normal infant here means infant born after >37 weeks of gestation including low birth weight infant (Dewey 2001: 9). Based on clinical and epidemiological data, they suggested five phases for IYCF practices. Those phases are (1) *breast-feeding initiation* within an hour of birth; (2) *exclusive breast-feeding* started from birth until six months of age; (3) *complementary feeding* started from 6 to 24 months of age; and (4) *family food feeding* fully implemented around 24 months of age (Sellen 2007: 130). These phases are illustrated schematically on Figure 2.4.

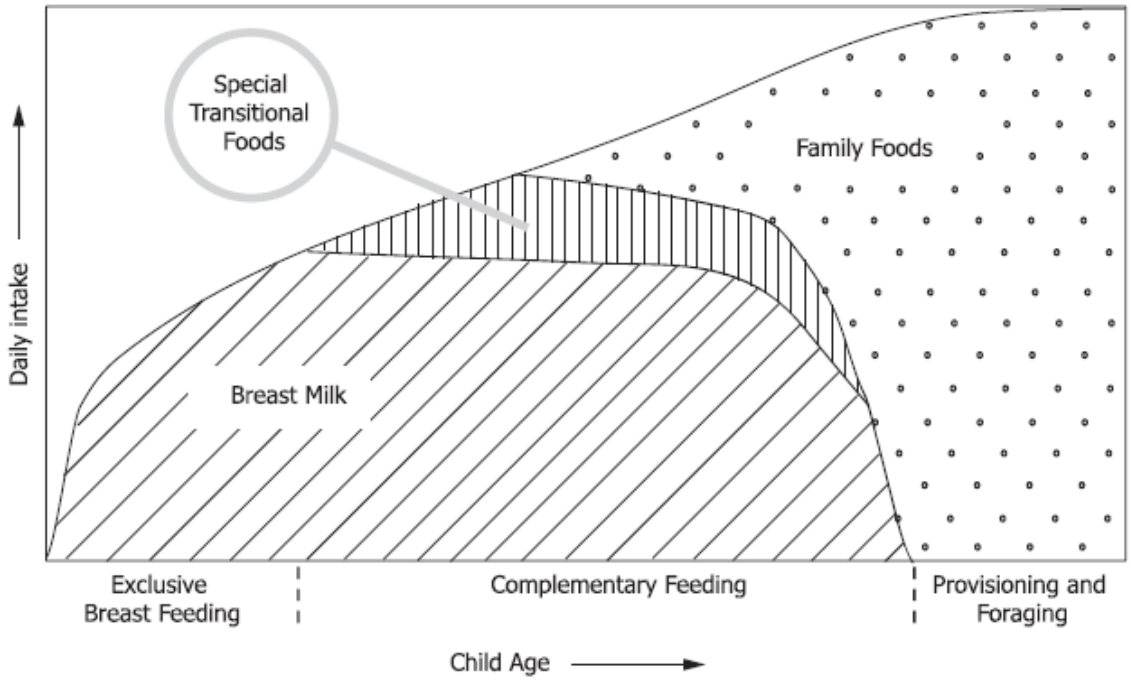


Figure 2.4 Feeding phases optimal for healthy infant and young children

Source: Sellen (2007: 131)

Breast milk

Breast-feeding initiation is the initial key success of early nutrition programming. In this stage, the baby is recommended to be placed skin-to-skin near the mother's breast and assisted to be breastfed within the first hour after the birth (WHO 2003: 5; Sellen 2007: 130). Extra help is needed for mothers who have had a caesarean section to initiate breast feeding to prevent late initiation and soon termination of breast feeding. This stage might support the breast feeding success, lengthens the duration of breast feeding, and strengthen the bonding between the baby and the mother which might enhance the psychological development (WHO 2003: 5).

International public health recommendation suggests that to reach optimal growth, the infants should be exclusively breastfed for the first six months of their life (WHO 2003: 7). This optimal duration is based on a systematic review (Kramer and Kakuma, 2002: 11f) and general conclusion by World Health Assembly 2001 (WHO 2003: 7; Dewey 2001: 10). Exclusive breast feeding is a feeding practice in which the child is only breast milk-fed (including expressed breast milk or breast milk from wet nurse) (WHO 2003: 7; WHO 1991: 4; Binns et al. 2009: 174f). No other foods or liquids are given during this period, except vitamins, minerals, and medicines in the form drops, syrups or vaccination in the emergency reason (WHO 1991: 4; Binns et al. 2009: 174f).

Six months exclusive-breast feeding practice evidently has correlation with enhancing the immune system of the baby, so that this increase the chance to survive from many illnesses, particularly from diarrhoeal and pneumonia disease, two main causes of the infant mortality (WHO 2003: 7; Black et al. 2003: 2226). This practice also might protect the infant from gastrointestinal infections (Fewtrell et al. 2007: 635S), and induce their cognitive developments (Dewey et al. 2001: 262). For the mother, this practice might prolong the durations of lactational amenorrhea and accelerates weight loss (Dewey et al. 2001: 262). Nutrients need for normal infant is should adequately meet from exclusively breast milk of healthy mother (Dewey 2001: 10). Some micronutrients like iron, zinc and certain vitamins (such as vitamin A, riboflavin, vitamin B6, and vitamin B12) may become limiting on breast milk before the baby is 6 months old. In this case, supplement drops for infants or diet improvement of mothers or supplement drops for mothers are evidently more effective compared to introduce the complementary food for infants below 6 months (Dewey 2001: 10; Cohen et al. 2004: 291f; Dewey et al., 1998: 878). In this period, giving the complementary foods tends to replace the breast milk rather than to improve the nutrient intake (Dewey 2001: 11; Dewey et al. 1994:

683). Therefore, in the case of malnutrition, the breast milk is still the best option during the first six months of human life.

To improve the practice of exclusive breast feeding, the international recommendation offers some solutions for employment mother, i.e. paid maternity leave, part-time work arrangements, on-site crèches, facilities for expressing and storing breast milk, and breastfeeding breaks (WHO and UNICEF 2003: 8). ILO Maternity Protection Convention, 2000 No. 183 and Maternity Protection Recommendation, 2000 No. 191 provide a regulation to protect the right of new born baby including that the institution should provide maternity leave period, day-care facilities and paid breastfeeding breaks (WHO and UNICEF 2003: 13).

Complementary food

To obtain optimal growth, the infants should start to receive complementary food on six months of age while breastfeeding continues up to two years or beyond (WHO 2003: 9; Dewey 2001: 10). Breast milk still become an important source of nutrition particularly essential fatty acids and certain micronutrients, fluid and immunological protector for the baby on 6 to 24 months of age (Dewey 2001: 12; WHO 2003: 9). The breastmilk feeding on this period also might be an important tool for bonding which might enhance psychosocial development (WHO 2003: 9). Moreover, this continued breast feeding practice might prolonged maternal infertility postpartum (Dewey 2001: 12). For the baby, this practice might reduce the risk of morbidity and mortality (Davis 2001: 125; WHO Collaborative Study Team on the Role of Breastfeeding on the Prevention of Infant Mortality 2000: 451), obesity (Butte 2001: 189; Metzger and McDade 2010: 291), and improved the cognitive ability (Reynolds 2001: 159). Complementary food is a sterile nutrient-dense food which is fed to a child after the period of exclusive breast feeding to complement the children needs uncovered by the breast milk only. This is a transitional period between exclusive breast feeding and family food (Dewey 2013: 2050; WHO 2003b: 13).

Infant formula / Breast milk substitute

Breast milk is the best option for optimal growth of infant, and it is recommended to be given exclusively till six months of age and continued till 2 years old or beyond (Dewey 2001: 10; WHO and UNICEF 2003: 7f). International recommendation suggest that this practice should be protected, promoted and supported (WHO and UNICEF 2003: 15). However in some circumstances, the breast milk is not able to be delivered or not

suitable for the baby or no longer able to be fed to the infant, such as mother's illness, mother's medication, the mother have to work, or other reasons such as breast refusal, perceived poor milk supply, breast and/or nipple pain, previous breast surgery, caesarean or premature birth, negative postnatal experience, lack of support, a return to work (Wilkinson and Scherl 2006: 6; WHO and UNICEF 2003: 10). In these cases, there are some alternative choices like expressed breast milk from an infant's own mother, breast milk from a healthy wet-nurse or a human-milk bank, or a breast-milk substitute (WHO and UNICEF 2003: 10). However, for mothers who test negative for HIV, or who are untested, exclusive breastfeeding remains the recommended feeding option (WHO and UNICEF 2003: 19).

In the case that the breast milk is unable to be fed to the infant, an appropriate high quality of breast milk substitute (BMS) is very demanded to ensure that the infants meet their nutritional needs and optimal growth (Koletzko et al. 2005: 586). This substitute commonly known as infant formula, "a product based on milk of cows or other animals and/or other ingredients which have been proven to be suitable for infant feeding" (Koletzko et al. 2005: 586). Codex Alimentarius (2011: 1) defined the infant formula as "a breast-milk substitute specially manufactured to satisfy, by itself, the nutritional requirements of infants during the first months of life up to the introduction of appropriate complementary feeding". It is very important to know that cow milk or other animal/plant nutrient-dense sources are not possible to be offered directly to the children under one year of age because their kidney on this age is not fully developed and those foodstuffs have very high renal solute load (Koletzko et al. 2005: 586).

Infant formula is become a premium food since it is a sole food for infant in the most cases and inappropriate handle along the chain from udder to bottle might cause severe health problem to the infant, such as diarrhoea, undernutrition, dehydration, overnutrition, hypernatremia, bacterial infection, or even death (Labiner-Wolfe et al. 2008: S85; Leung et al. 2009: 70). Therefore, the standard quality for production and preparation is higher than the other commercial food products (Codex Alimentarius 2011: 1). Incorrect dose of infant formula in the aspect of quantity and nutrient composition might induce hypernatremic dehydration which might cause seizures, cerebral edema, venous sinus thrombosis, pontine myelinolysis, permanent brain damage, disseminated intraveasculas coagulation, acute renal failure, and even death (Leung et al. 2009: 70).

Infant formula development started more than 150 years ago (Koletzko et al. 2014). Along this period, the composition of infant formula was reviewed and improved through continuous research and innovation in order to provide high quality food for infants to support their optimal growth and development. In the early development, the infant formula is formulated to mimic the human breast milk components. But in the later development, it is realized that the component on the different matrix food will give the different effect on human body. For instance, the zinc content in infant formula is set higher since this component has lower bioavailability on infant milk compared to the zinc contained in the breast milk. Similar composition does not guarantee the overall needs of the infant. The composition analysis is not sufficient to determine the quality of infant formula. Therefore, nowadays, the infant formula is formulated not to replicate the components of breast milk, but it is formulated in order to give similar physiological (e.g. growth patterns), biochemical (e.g. plasma markers) and functional (e.g. immune responses) results/effects as the breast milk do to the common healthy exclusively breast fed infants (Koletzko et al. 2005: 586). This should be created as best as possible to fulfil all nutritional requirement of the infant. The quantity and quality particularly in the aspect of safety should be really attained as this becomes the only intake for infants especially in their first six months of life. Moreover, during this period the rate of the growth and development is on the peak and some organs are not fully developed. Other nutrient dense foods like cow's milk is not possible to be offered to the babies since it is very high renal solute which is to overload for children below one year when their kidney is not fully developed (Koletzko et al. 2014; Hernel 2011: 19).. Therefore, breast milk or its substitutes are the only option for children under six months of age.

International code for marketing of Infant formula

In the paid employment mothers' point of view, infant formula is much more efficient and easy to practice compared to the expressed breast milk. However in this case, breast milk feeding is the top choice and urgently to be supported by the environment. To prevent early cessation of breast milk feeding, in 1981, WHO endorced an International Code of Marketing of Breast-milk substitutes (WHO 1981). According to the codes, the infant formula manufactures may not promote their products in hospitals, shops or to the general public; give free samples to mothers or free or subsidized supplies to hospitals or maternity wards; give gifts to health workers or mothers; promote their products to health workers: any information provided by companies must contain only scientific and factual matters; promote foods or drinks for babies; give

misleading information; and do not have direct contact with mothers (WHO 1981: 10ff, UNICEF 2013: 6ff*).*

This code is not legally binding. Therefore, although 30 years have been passed since endorsement, WHO (2013) reported that only 19% of the member states have passed the codes, and only 23% of them who functioning monitoring system. Collaboration, co-operation and communication are urgently required at all levels to ensure the success of the implementation of the Code.

Milk for young children

After the infant is fully weaned from breast milk and fully consume the family food, it is still recommended to include milk as a part of their diet. Milk is a favourable source of calcium due to its bioavailability in the body for supporting the healthy development of children, especially for their teeth and bones. The National Institute of Health (2013) recommends children 1 – 3 years old to consume 550 ml low fat milk to fulfil daily intake 700 mg of calcium. Other calcium-rich foods like yoghurt and cheese could be possible as well to cover the daily need of calcium. Calcium is the largest mineral contained in the human body. Childhood is the period where the calcium need is very high when the bone formation exceeds the calcium resorption (NIH 2013). Furthermore, milk is a superior food which enables to deliver a lot of nutrients particularly micronutrients for the body per total energy in such a wonderful balance emulsion which is easily available and absorbable in the body (Steijns 2008: 426).

2.4 Profile of Bogor, West Java, Indonesia

Bogor is placed in the western part of Java Island, province of West-Java. Bogor is potitioned about 60 km south of the Indonesian capital Jakarta and 85 km northwest of Bandung (Figure 2.1).

Figure 2.5 Location of survey: Bogor (red area), West-Java province of Indonesia
Source: Bogor location map 2012

Geographically, Bogor is bordered by Tangerang, Depok, Bekasi, Banten, Sukabumi, Cianjur, and Karawang. It consists of two areas, i.e. Bogor City and Bogor Regency (Figure 2.2). The City is divided into 6 sub-districts with 68 villages, while the Regency is divided into 40 sub-districts with 422 villages.

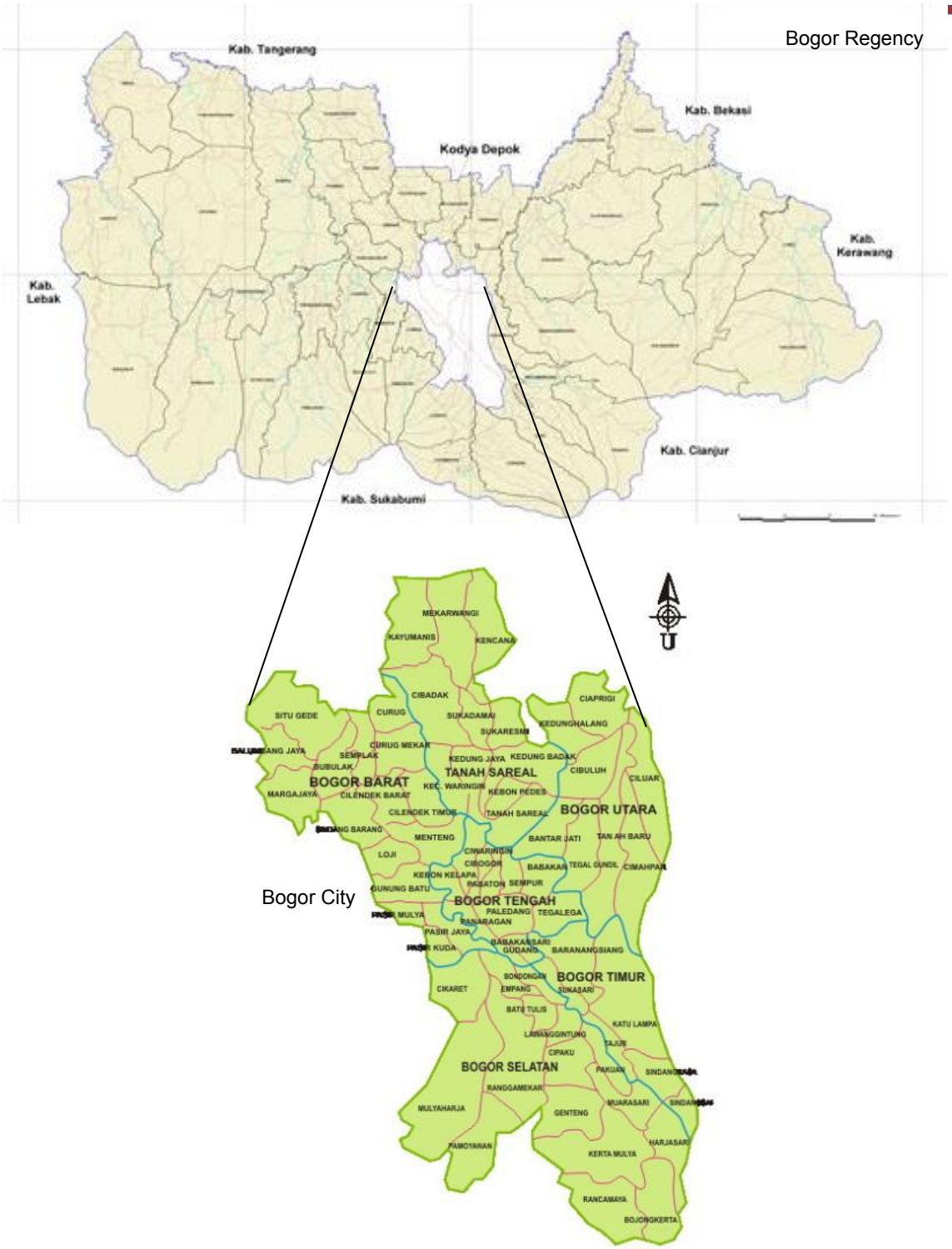


Figure 2.6 Maps of Bogor City and Bogor Regency

Source: Bogor location map 2012

History and population

In the Middle Ages (1482-1746), Bogor City was the capital of Sunda Kingdom (Kerajaan Sunda) named Pakuan Pajajaran, that in old Sundanese means “a place between the parallel/rivers”. Over the next several centuries, this area became one of the largest cities in medieval Indonesia. The chronicles written in Sanskrit, a language for official and religious purposes using Pallava writing system on rock stellas called *prasasti*. Bogor has a number of *prasasti* differ in shape and text style which become one of the main attracted objects for tourism. (kotabogor.co.id 2014)

During the Dutch colonial era, this city was famously named as *Buitenzorg* (Dutch for “beyond concerns” or “without worries” or “carefree”, 1746-1942) which served as the summer residence of the Governor-General of Dutch East Indies. The formal transition from Sultanate of Banten to the Dutch East India Company (VOC) occurred on 17 April 1684 by signing an agreement between the Crown Prince of Banten and the VOC. In 19th century, the city was the administrative centre of the Netherlands East Indies during the British control. (kotabogor.co.id 2014)

In 1860-1880, the largest agricultural school in the colony was established in Buitenzorg together with the construction of other scientific institutions like a city library, natural science museum, biology, chemistry, and veterinary medicine laboratories. Then during the World War II, Buitenzorg was occupied by Japanese forces until 17 August 1945, the Indonesian Independence Day. Due to the sentiment from the local people to the colonialism, then the Indonesian people gave an Indonesian name to this city, namely “Bogor”. Further, the famous Bogor palace which formerly was used for the summer residence of the governor general became a summer palace of the President of Indonesia. (kotabogor.co.id 2014)

At the moment, Bogor is one of the world’s most densely populated area. Currently in the early of 2014, over 6 million people (Bogor Regency 5,131,798; Bogor city 1,022,002; total 6,153,800 people) living on area of about 2,782.33 km^2 (Bogor Regency 2,663.83 and Bogor City 118,5 km^2) (BPS 2014: 20). About 28.39% of the inhabitants were under 15 years old, 67.42% were 15-65 years old and 3.51% were over 65 years. Bogor has a presidential palace and a botanical garden, one of the oldest and largest gardens in the world. This garden is very famous iconic by the giant flower, *Rafflesia arnoldii* and *Rafflesia patma* grows with diameter about one meter and weight about 10 kg. Due to the frequent rain, Bogor also has a famous nickname as

“the Rain City” which always rains even during the dry season, with the rainfall 3,500-4,000 mm/year and the average relative humidity is 70%. (kotabogor.co.id 2014)

The fast economic growth of Bogor occurred in 19th. The major contribution was coming from the production of coffee, rubber, timber, metal, and chemical industry. Then it slowed down by the economic crisis in 1990. The new comers of poor residents from other area increase the population lived below the poverty level till 17.45% in 2013. At the moment, the economic sector in Bogor was supported 31.27% from hotel and restaurant business, 26.44% from industry, 12.35% from financial services, 10.62% from transportation and communication, 8.5% from construction, 7.37% from costumer services, 3.06% from energy and water supply and 0.4% from agriculture. The main crops are rice, various vegetables, corn, and sweet potato. And the main livestock are cows, sheep, chickens, and ducks. The majority fish was produced for export commodity, mostly to Japan and Middle East. (kotabogor.co.id 2014)

The largest agricultural school and many scientific institutions which was established in 18th is still maintained and developed. These become one of main assets for Indonesia. This agricultural school is now wellknown as “Institut Pertanian Bogor” or IPB (Bogor Agricultural University). Therefore, this city is become one of the major scientific and educational centres in Indonesia till now. (kotabogor.co.id 2014)

3 Methodology

The present study was executed through three main stages, i.e. survey – a case study in Bogor, West Java, Indonesia (section 3.2); basket survey of milk products (section 3.3); and data analysis (section 3.4). Before going to the research method into detail, the first section (3.1) will present the reserach hypothesis of the study based on the theoretical background.

3.1 Research hypothesis

The quality of children's growth and development is very much determine the quality of a nation. A figure of child nutritional status in Asian developing countries views a miserable fact, i.e. a high prevalence of double burden child malnutrition (UNICEF et al. 2014: 2). As a developing country apart of Southeast Asia, Indonesia is predicted to has high prevalence on dual child malnutrition, i.e. undernutrition on one side and overnutrition on the other side.

Undernutrition or insufficient nutrient intake relative to the real needs during the infancy and childhood might harm the child growth and development, particularly the brain development. Brain develops sproutly and very fast during the early human life (Benton 2010a: 457). The insufficient intake during this early period might influence the quality of the brain development. This golden moment during the early life could not be paid-off on the later life (Thompson and Nelson 2001: 8). Hippocampus is one of the earliest areas to show cortical-cortical connectivity and functionality (Georgieff 2007: 6146). Nutrient deficiency in the early stages can affect differentiation in this area which influences the cells numbers and complexity, which then affect the functionality (Georgieff 2007: 6146). Therefore, the undernourished state during the early life might disturb the brain development which then might impair the cognitive perfomance, particularly the memory ability.

Overnutrition or excess nutrient intake relative to the real needs during the early life might cause the fat adiposity and megacell growth in children (Koletzko 2009: 17). This highly potential to produce childhood obesity and more likely to grow as obese adult (Von Kries et al. 1999: 1). The excess of adiposity during the infancy and childhood might induce inflammation and atrophy of grey matter in hippocampus area which responsible to the cognitive performance, especially memory ability (Smith et al. 2011:

750). Thus, child overnutrition also might impair the child cognitive performance.

Milk places a notable portion of children diet which enable to deliver abundant of macro and micro nutrient to the body in a way of wonderful emultion water in water so that easily to be digested in the body (Steijns 2008: 426; WHO and UNICEF 2003: V). Malnutrition is close related to the matter of nutrient intake quality (WHO and UNICEF 2003: V). Study on the milk intake pattern among the young might gave a picture on the phenomenon of double burden malnutrition (Koletzko 2009: 17).

Moreover, the nutrient intake quality of the children is depend on the food choice. The food choice in the context of society is very close linked to the socioeconomic status of the family. It is particularly the education, occupation and income of the parents (Roshita et al. 2013: 347; Tzioumis et al. 2014: 230).

From above discussion, it could be drawn three main research hyphotesis of the study, those are (1) Indonesia is facing a serious double burden child malnutrition; (2) double burden child malnutrition influences the cognitive performance of the children, particularly the memory ability; and (3) double burden malnutrition has a strong correlation with milk intake pattern and socioeconomic status of the children.

3.2 Survey: A case study in Bogor, West Java, Indonesia

The following chapter describes the detail design related to the survey, i.e. location, study design, parameters, materials, population and sample.

3.2.1 Location

The survey was performed in Bogor, West-Java province of Indonesia (see section 4.2, Figure 2.1, and Figure 2.2).

3.2.2 Study design

The study was performed as a cross-sectional study design. That is a survey with questionnaire which is completed to address some parameters at a specific point in time (Rindfleisch et al. 2008: 262). The target beneficiaries of this study were Indonesian malnourished children age 5 to 6 years who lived in Bogor area, West-Java, Indonesia. The study was initiated on November 2012 and ended on December 2013.

The survey consists of two batches. The first batch was conducted to obtain the most exact representative picture of the beneficiaries. The second one was conducted to obtain the most representative sample size for each category of the underlying parameters, in this case was nutritional status, especially for BMI-for-Age which divided into five categories, i.e. Severe Acute Malnutrition (SAM), Moderate Acute Malnutrition (MAM), normal, overweight, and obesity. From the entire survey method, only the sampling technique was different between both batches. While, the rest of the survey method for the both batches i.e. design, beneficiaries, parameters and materials was performed in exactly the same treatment.

3.2.3 Parameters

There were four main parameters observed on this current study i.e. socioeconomic status, nutritional status, milk consumption, and some brain development indicators.

The observed ***socioeconomic status*** of respondent were survey location, sex, education, maternal education, parental education, maternal occupation, paternal occupation, monthly income, monthly expenditure on food, household members, and birth order. Some other general birth profile also recorded on this study. Those are birth method, birth weight, birth length, method of breast-feeding, and length of breast-feeding.

A series of ***nutritional status*** indicators were assessed according to WHO reference 2007 for children age 5 to 6 years old, i.e. Weight-for-Age, and BMI-for-Age (WHO 2013).

Milk consumption frequency and dietary recall two times 24 hours were assessed to calculate probability and amount of milk intake. Then the usual daily milk intake was calculated by using Multiple Source Method (MSM). The profile, milk consumption frequency and dietary recall two 24 hours of the respondent were gathered by interviewing the mother of the child or other adult member. The interview and the anthropometric measurement were performed by the author assissted by four trained enumerators from Department of Community Nutrition, Bogor Agricultural University (IPB).

The author, de Souza et al. (2011: 135) mentioned that ***brain development*** status is possible to be assessed according to some cognitive performance indicators. Those indicators are memory, learning, and attention ability. A series of brain development

indicators, i.e. memory, learning, attention, Intelligence Quotient (IQ) and Emotional Quotient (EQ) were assessed by using Projective Multi-phase Orientation method (PMPO). The PMPO is a validated instrument to measure a simple series of brain development indicators. The test was conducted at a pre-school education centre and consisted of the performance of two tasks, i.e. drawing three trees and asking some memorial and logical questions. The test and the result analysis were performed by GRAHITA INDONESIA, an education consultant institution who specialized in psychological appraisal for children emotion development. Grade 0 to 100 was used for scoring memory, learning and attention ability according to true and false answers. Weschler scale was used for expressing the IQ score (Hrabok et al. 2012: 8; Grahita Indonesia 2013). While the EQ was scored by using the total of 12 points of emotional type, i.e. achievement, self-defence, autonomy, self-assertion, cooperation, concern, dependence, domination, indecision, constancy, heterogeneity, and aggressiveness (Hrabok et al. 2012: 8; Grahita Indonesia 2013). The detailed classification of the cognitive score is available on Table 3.1.

Table 3.1 Classification of cognitive score

Memory, learning, and attention		**IQ**		**EQ**	
Score	**Class**	**Score**	**Class**	**Score**	**Class**
90 – 100	Perfect performance	> 160	Supra genius	550 – 600	Perfect performance
70 – 89	Superior	141 - 159	Genius		
50 – 69	Normal	131 - 140	Gifted	500 – 549	Superior
30 – 49	Low performance	110 - 130	Superior	400 – 499	Normal
< 30	Underline	90 - 109	Normal	350 -399	Low performance
		70 – 89	Borderline		
		50 – 69	Debil	< 350	Underline
		< 50	Ideot		

Source: Hrabok et al. 2012: 8; Grahita Indonesia 2013

3.2.4 Materials

The following materials were used during the survey: digital body weighting scale (*Camry*), length measuring board (*microtoise*), and questionnaire (appendix 1). A structured coded questionnaire was used to record profile of respondent and family, anthropometric measurements, history of breast feed and milk consumption, milk consumption frequency and dietary recall for two 24 hours. Milk investigation was conducted on five types of milks, i.e. breast milk, heated milk, formula milk powder, condensed milk, and reconstituted milk. The types, amounts, brands, prices, and tastes were recorded and further investigated using basket survey (section 3.3). Heated milk is a product obtained by heating the fresh milk such as pasteurisation and sterilisation. Formula milk powder is a product produced by formulation and spray drying the milk

which formulated in a way that the nutrition composition suitable for targeted consumer. Condensed milk is a product resulted by adding extra sugar and condensing it by using evaporation. While the reconstituted milk is a dairy product obtained by addition of water to the dried or concentrated form of milk in order to produce an appropriate water to solids ratio of milk product (CODEX STAN 206-1999-*1*).

3.2.5 Population and sample

3.2.5.1 First batch

The target study population was children age 5 to 6 years old who live in Bogor. The number of target population was about 222,926 children which 37,154 children live in Bogor city and 185,771 live in Bogor regency in 2010 (calculated from BPS 2013).

Sample size was calculated by using Cochran's sample size formula, i.e.:

$$n_0 = \frac{t^2 \times s^2}{d^2}$$

where n_0 is the required return sample size, t is the value for selected alpha, s is the estimation of standard deviation in the population, and d is the acceptable margin error on the study (Bartlett et al. 2001: 46).

According to previous study, the milk consumption quantity of children age 4 to 6 years old in Indonesia was 18.6±55.4 ml/capita/day (Riskesdas 2010). Therefore, the required return sample size of this study with alpha level 0.05 ($t = 1.96$), standard deviation in the population 55.4 ml/capita/day (s), and acceptable maximum error on this study 10 ml/capita/day (d), was:

$$n_0 = \frac{(1.96)^2 \times (55.4)^2}{(10)^2} = 118$$

Since the sample size did not exceed 5% of the population i.e. about 0.05% (118 from total population about 222,926) so that the correction formula did not necessarily to be applied (Bartlett et al. 2001: 46). Hence the minimum sample size of this study to represent the beneficiaries was 118 children. In the field, the sample size was adjusted to anticipate the low response rate. The sample size was adjusted by following calculation:

$$n_n = \frac{n}{response\ rate}$$

where n_n as the sample size adjusted for response rate (Bartlett et al. 2001: 47).

There is no stick figure of response rate. Generally, in social research studies, the response rate of the respondents is estimated about 65% (Bartlett et al. 2001: 47). Therefore, the sample size adjusted for response rate on this study was:

$$n_n = \frac{118}{65\%} = 182$$

In the end the initial targeted sample size for this study was 182 children age 5 to 6 years old who lived in Bogor.

In order to look for the most exact representative picture of the population, a partial sampling unit method was applied. A probability sampling design with proportional stratified sampling method according to the number of children per area (in this case Bogor City and Regency) was applied. Selection of villages was executed by simple random sampling method using random numbers. As many as 6 villages were selected as the target survey. Those villages were (1) Kelurahan Mulyaharja, Bogor Selatan, Bogor City; (2) Desa Bojong Baru, Kecamatan Bojong Gede, Bogor Regency; (3) Desa Gunung Sari, Kecamatan Pamijahan, Bogor Regency; (4) Desa Karadenan, Kecamatan Cibinong, Bogor Regency; (5) Desa Babakan, Kecamatan Darmaga, Bogor Regency; and (6) Desa Gunung Malang, Kecamatan Tenjolaya, Bogor Regency.

Eligibility criteria for recruitment were (1) children age 5 to 6 who live in Bogor; (2) absence of severe chronic medical problems affecting food intake; and (3) absence of chronic psychological disorder.

A pre-study was performed in Village Babakan – Kecamatan Dramaga, Bogor. As many as 44 children age 5 to 6 years old were recruited from this village. Twenty children were selected from kindergarten, a formal preschool education, as the representative upper middle class. The school fee of this kindergarten is more than 20 USD/month. Then 20 children were selected from integrated pre-school education centre, an informal preschool education, as the representative of lower middle class with fee 1.5 USD/month. And four children who stay home and do not follow any education program were selected as well as respondents.

This pre-study was intended to make the enumerators become familiar with the questionnaire, to affirm that the questionnaire will get the information needed, and to eliminate some questionnaire bias such as: double barrel questions, ambiguous

questions, leading questions and phrases, question difficulty, unbalanced response categories, and some missing response categories (Shao and Zhou 2007: 197f; Aaker et al. 2007: 334). After the assessment of the data quality and completeness, and to protect the representative figure of the beneficiaries, as many as 37 respondents of this pre-study were also included in the study. In the end as many as 221 children of which 37 children from Bogor City and 184 children from Bogor Regency were chosen as the representatives of the beneficiaries (Table 3.2).

Indonesian government has regulated the pre-school education in Undang-Undang (UU) No. 20 in year 2003. The rule mentioned that pre-school education was intended to prepare the children below 6 years old so that be mature to be admitted in elementary school (UU No. 2 2003: 28 (1); KPPPA and BPS 2012: 18). The regulation mentioned that there are two types of preschool i.e. formal (TK/RA/BA; 67.87%) and informal preschool education (Integrated PAUD; 32.13%) (KPPPA and BPS 2012: 21).

Most of those children (161; 72.85%) were recruited from pre-school education centre, both formal- (109; 67.70%) and informal- preschool education (52; 32.30%). This proportion was drawn according to the participation rate of Indonesian children age 5 to 6 years old in formal- and informal- pre-school education, 67.87% and 32.13% respectively (KPPPA and BPS 2012: 21).

Table 3.2 Proportion of respondents according to the location and education

Characteristics	**N**	**%**
Survey location (respondents)		
Bogor city: Kelurahan Mulyaharja, Bogor Selatan	37	16.74
Bogor Regency	184	83.71
Desa Bojong Baru, Kecamatan Bojong Gede	37	16.74
Desa Gunung Sari, Kecamatan Pamijahan	37	16.74
Desa Karadenan, Kecamatan Cibinong	37	16.74
Desa Babakan, Kecamatan Darmaga	37	16.74
Desa Gunung Malang, Kecamatan Tenjolaya	36	16.74
Child's education (respondents)		
Formal pre-school education	109	49.32
Informal pre-school education	52	23.53
Children stay home	60	27.15
Total of respondents	221	

KPPPA and BPS (2012: 19) reported that only 33.35% of 9 million Indonesian children age 5-6 years old that participated pre-school education in 2011, which means that the majority Indonesian children age 5 to 6 years old are still staying at home (66.65%). However, due to the low participation rate among children who stay at home, there are

only 60 (27.15%) stay at home children who were desired to be enrolled in this study (Table 3.2). These children were recruited from the integrated service post (Posyandu/Pusat Pelayanan Terpadu).

3.2.5.2 Second batch

The second batch aims to obtain equal representative sample size per BMI-for-Age category. From the first batch, it was gathered as many as 221 respondents with the following nutritional status proportion (Table 3.3):

Table 3.3 Nutritional status of the respondent from the first batch of the study according to BMI-for-Age z-score from WHO 2007

Nutritional status	BMI-for-Age z-score	Number			Percent
		Boys	Girls	Total	
SAM	< -3	34	26	60	27.15
MAM	-3 ≤ z < -2	28	27	55	24.89
Normal	-2 ≤ z ≤ 1	47	42	89	40.27
Overweight	1 < z ≤ 2	4	4	8	3.62
Obesity	> 2	5	4	9	4.07
Total respondent		118	103	221	

Note: BMI: body mass index, calculated as kg/m2; SAM: Severe Acute Malnutrition; MAM: Moderate Acute Malnutrition; z: z-score.

Source: Palupi et al., 2013

There was a sufficient number of respondents for category SAM, MAM, and normal children, i.e. 54, 62, and 91 respondents respectively. But, only limited sample size that obtained for overweight and obese children, i.e. 8 and 6 children respectively. Therefore this second batch of survey was looking particularly for overweight and obese children. Normal children were also targeted to be included on this second batch as the standard to be able to assess that there was no significant different treatment between the first and the second batch. Mann-Whitney U test between batch one and two was performed to see whether there were any significant difference between two batches for category normal children. The test revealed that there is no significant different (*p-value* > 0.05) between both batches, especially for key parameters, i.e. cognitive performance (memory, attention, learning, IQ, and EQ). All except the sampling method and respondent were maintained to be exactly the same between both batches. Cut-off sampling method was applied for the second batch by selecting the area which has a high proportion of targeted participants, in this case overweight and obese children.

Prevalence of overweight and obese children was higher in urban area (about 8.8%) than in rural area (about 3.2%). Therefore, Bogor city was targeted as the survey

location for the second batch. As many as 186 children were recruited from five kindergarten in Bogor City, i.e. Bogor Utara, Bogor Selatan, and Bogor Tanah Sareal. Some SAM- and MAM- children were also recruited. In the end as many as 407 children were obtained from the first and the second survey. After being reduced due to some incomplete data and outliers (z-scores > ± 3.29), the total respondent became 387 children with the following nutritional status proportion (Table 3.4).

Table 3.4 Nutritional status of the respondent from the first and the second batch of the study according to BMI-for-Age z-score from WHO 2007

Nutritional status	BMI-for-Age z-score	Number			Percent
		Boys	Girls	Total	
SAM	< -3	30	30	60	15.50
MAM	-3 ≤ z < -2	30	31	61	15.76
Normal	-2 ≤ z ≤ 1	80	83	163	42.12
Overweight	1 < z ≤ 2	26	17	43	11.11
Obesity	> 2	34	26	60	15.50
Total respondent		200	187	387	

Note: BMI: body mass index; calculated as kg/m2, SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition.

3.3 Basket survey of milk products: milk composition

A basket survey was conducted to recognize the nutritional composition of the milk consumed by the beneficiaries. There are four types of milk available for children age 0 to 6 in Bogor – Indonesia, i.e. heated milk, formula milk powder, reconstituted milk, and condensed milk. The nutrition facts and the serving size of these milks were observed, listed, and recorded to calculate the cumulative mean value of the milk composition. The types, amounts, brands, prices, and tastes were also investigated during the basket survey. Composition of whole cow milk and breast milk from some references were also recorded and calculated as comparison. There were four categories available for formula milk powder, i.e. infant formula for infant age 0 – 6 and 7 – 12 months old, and follow on formula for children age 1 – 3 and 4 – 6 years old. In the end as many as 10, 15, 19, 23, 8, 8, and 4 brands observed for milk formula powder category age 0 – 6 months, 7 -12 months, 1 – 3 years, > 3 years old, reconstituted milk, condensed milk, and heated milk respectively.

3.4 Data analysis

Anthropometric measurement results were analysed according to WHO reference 2007 by using WHO AntroPlus software version 1.0.4 (WHO 2013). Weight-for-Age z-score and BMI-for-Age z-score were analysed to obtain the nutritional status of the respondents. Frequency test and cross tabs were performed to analyse the profile and the frequency of nutritional status of respondents. Two initial explorative tests were conducted before the data was further analysed, those tests are outliers test and normality test. Data with z-score greater than 3.29 were excluded from the data set (Field et al. 2012: 146). Then normality test was performed for the underlying parameters, i.e. milk intake and cognitive performance. This test revealed that the analysed parameters were not normally distributed with *p-value* < 0.05. Therefore non parametric test Mann-Withney U and Kruskal Wallis-H were performed as further analysis. A calculation with sample size as weighting factor was applied to obtain cumulative mean value of milk composition. All above tests were conducted by using SPSS version 16.0.

Usual daily milk intake was calculated by using Multiple Source Method (MSM). The MSM is a new validated method to estimate the usual food intake according to short-term measurement data (Haubrock et al. 2011: 914; DifE 2011: 3). Milk consumption frequency and dietary recall for two 24 hours data were used for calculating the usual daily milk intake. The method estimates the usual intake by combining the probability (from Food Frequency (FFQ) data) and the amount of consumption (from dietary recall two 24 h) (DifE 2011: 3; Haubrock et al. 2011: 914). The method was applied to tackle the weaknesses of dietary recall which tend to be underestimate and food frequency which tend to be overestimate (DifE 2011: 3). Dietary recall for two 24 hours were assessed by using Nutri-survey 2007.

The calculation of usual milk intake using MSM was done online through the link https://msm.dife.de/ (DifE 2011: 7f). There were four stages of this method, those are loading the data, defining the model, running the calculation, and reviewing the results (DifE 2011: 9ff). Seven parameters were inputed as the initial information, i.e. code of respondents (code), amount of milk intake from dietary recall two 24 h in mL (ml), BMI of the respondents (bmi), frequency of milk consumption (ffq: times per day), age (age: in years old = years + (months/12)), sex (sex: 1 for female and 2 for male), and age times sex (agesex). This was applied for all types of milks, i.e. heated milk, formula milk powder, condensed milk, and reconstituted milk. “bmi+sex+age+agesex+ffq” was

inputed as the model structure with “ml” as the response and “ffq” as the consumption frequency parameter.

Multivariate statistical analysis i.e. PCA (Principal Component Analysis) and MLR (Multiple Linear Regression) were used to synthesis the final conclusion and suggestion from the broad parameters and samples (Esbensen 2010). Unscrambler 10.2 software was applied for these analyses.

4 Results

There are three main results which are going to be presented in the following three sub chapters. The first sub chapter (4.1) describes the profile of the main observed parameters, namely socioeconomic status, nutritional status, and milk consumption pattern. The second part (4.2) examines the correlation between double burden child malnutrition and some brain development indicators. The last sub chapter (4.3) investigates the linkage among double burden child malnutrition, socioeconomic status, and milk consumption.

4.1 Profile of the observed parameters

The record of socioeconomic status, nutritional status, and milk consumption pattern of the respondents are going to be described in the following sections.

4.1.1 Socioeconomic status (SES)

Education, occupation, and income are the main dimensions of socioeconomic status (Winkleby et al. 1992: 816). The main socioeconomic status of the respondents and their households are shown in **Table 4.1**.

A total of 221 children, 118 boys and 103 girls were enrolled in the current study. More than half of respondents (120; 54.3%) have low maternal education. Low education means never pursued any kind of senior school educations or the 12th grade of education. Even, more than quarter of mothers (65; 29.4%) was off on elementary school or 6th grade of education. And almost quarter of them (55; 24.9%) pursued only junior high school or 9th grade of education. A third of mothers only finished over from senior high school education (72; 32.6%). And only about 13% of them have pursued a higher education. The majority of them (154; 69.7%) are housewife and stay at home full time or nonworking mother. And only 18% of them are full time working mother. Education of fathers also has the similar pattern with the mothers. Almost half of respondents (94; 42.5%) have low paternal education, which 22.2% of fathers have quit on 6th grade of education, and 20.4% of them were off on 9th grade of education. 40.7% of the fathers were pursued only till a senior high school education. And only few of fathers (about 16%) pursued a higher education. So in general, from those figures, it could be drawn that about half of the beneficiaries is growing in the poor social

environment where both the fathers and mothers have low education. And the majority household income (69.7%) is supported only from father. So the majority typical household of the respondents is male-headed household.

Table 4.1 Characteristics of children and their households from the first batch of study

Characteristics (unit)	N	%
Total of respondents	**221**	
Male	118	53.39
Female	103	46.61
Maternal education (respondents)		
≤ 6th grade	65	29.41
6th - 9th grade	55	24.89
Completed high school	72	32.58
Some post secondary	20	9.05
Completed bachelor degree	8	3.62
Completed master degree	1	0.45
Maternal occupation (respondents)		
Housewife (full time at home)	154	69.68
Half time working	27	12.22
Full time working	40	18.10
Paternal education (respondents)		
≤ 6th grade	49	22.17
6th - 9th grade	45	20.36
Completed high school	90	40.72
Some post secondary	22	9.95
Completed bachelor degree	14	6.33
Completed master degree	1	0.45
Household members	4.31±1.22	
Birth order	2.18±1.11	
Household income (USD/month)	329.46±337.50	
Minimum	30.00	
Maximum	2,500.00	
< 200 (under minimum salary level)	81	36.65
200 – 299	53	23.98
300 – 499	42	19.00
500 – 999	35	15.84
≥ 1000	10	4.52
Income per capita (USD/month)	77.88±76.50	
Minimum	10.00	
Maximum	512.50	
< 25 (under poverty line)	31	14.03
25 – 49	67	30.32
50 – 99	72	32.58
100 – 249	42	19.00
≥ 250	9	4.07
Expenditure on food (USD/month)	151.82±96.13	
Main food	96.91±69.71	
Snack	41.31±15.97	
Milk	15.97±23.94	

Note: USD: United Stated Dollar (assumption 1 USD equal to 10 000 IDR); IDR: Indonesian Rupiah rates

To improve the human wellbeing among the people, the Indonesian Government implements the “Norma Keluarga Kecil Bahagia dan Sejahtera (NKKBS)” or the norms of small family, happy and prosperous. This norms appealed the people to plan a small

family with two children preferred and decent interval so that the children get sufficient intake and attention so that they grow and develop properly.The average number of household members in this study was 4.3±1.2 with average birth order was 2.2±1.1 children. This figure of household members was higher than the national figure, i.e. 3.7 in 2012 (BKKBN 2013: 22). Thus it can be stated that the household of beneficiaries has high fertility which the number of household members more than 4 and the birth order more than 2.

The average income of households was 329.5±337.5 USD/month with a large income gap, the minimum and maximum income was 30 and 2,500 USD/month respectively. The minimum salary level in Bogor area was 2,002,000 IDR/month or 200 USD/month in 2013 (PemKotBogor 2014: 1). More than a third of them (81; 36.6%) received income under the minimum salary level. The average income per capita was 77.9±76.5 USD/month, with a great gap, minimum to maximum was 10 to 512.5 USD/month. BPS reported that the poverty line for Bogor area was 25 USD/capita/month in 2013 (BPS 2014: 1). From this study, it is counted that 14% of the people included in this study lived under the poverty line.

On average, almost 50% of the income was expended for food (151.8±96.1 USD/month), which about 10% of this expenditure was allocated for milk (16±23.9 USD/month). But in the average respondents spent more for snack, which was 41.3±16 USD/month. It was almost a third of food expenditure was spent for snack or almost triple higher than the milk expenditure.

4.1.2 Nutritional status

According to WHO reference 2007 using BMI-for-Age z-score, 27.1% respondents are classified as severe acute malnutrition (SAM), 24.9% are classified as moderate acute malnutrition (MAM), 40.3% are classified as normal, 3.6% are classified as overweight, and 4.1% are classified as obesity. While using Weight-for-Age z-score, 2.7% respondents are classified as severe underweight, 13.6% are classified as moderate underweight, 78.7% are classified as normal, and 5.1% are classified as overweight (**Table 4.2**). This result demonstrates that the studied area is facing double burden child malnutrition, where there are two kind of child malnutrition detected when the survey was performed, i.e. undernutrition and overnutrition.

Table 4.2 Nutritional status of the respondents according to BMI-for-Age and Weight-for-Age z-score from WHO 2007

BMI-for-Age				Weight-for-Age			
Nutritional status	**BMIfAz**	**N**	**%**	**Nutritional status**	**WfAz**	**N**	**%**
SAM	< -3	60	27.15	Severe underweight	z < -3	6	2.71
MAM	-3 ≤ z < -2	55	24.89	Moderate underweight	-3 ≤ z < -2	30	13.57
Normal	-2 ≤ z ≤ 1	89	40.27	Normal	-2 ≤ z ≤ 2	174	78.73
Overweight	1 < z ≤ 2	8	3.62	Overweight	z > 2	11	4.98
Obesity	> 2	9	4.07				

Note: BMI: body mass index; calculated as kg/m2, BMIfAz: BMI-for-Age z-score; N: Number of respondent; %: percentage of respondent; WfAz: Weight-for-Age z-score; SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition.

4.1.3 Milk consumption pattern

The key qualification of milk consumption is "the right milk at the right time on the right amount". The following section describes the milk consumption pattern of the respondents. The description of the pattern is divided into two parts, i.e. period of infancy (0 – 2 years of age) and childhood (2 – 6 years of age).

4.1.3.1 Infancy

The pattern of milk consumption of the respondents from birth to two years of age is presented in **Figure 4.1**. Current study records that almost half (47.7%) of the nutritional requirements of infant age 0 to 6 months is covered by infant formula[3]. Another half (52.1%) of it is fulfilled by breast milk. And from the total respondents, it is calculated only 45.3% mothers who confessed that they have practiced an exclusive breast feeding for their children in which the breast milk is given as a sole food from birth to 6 months of age. And only 31.4% of mothers who continued to breast feed their infants till 2 years of age. Then the rest intake during this period is majority covered by follow-on formula[4] and child milk powder[5], i.e. 60.4 and 60.7% for age 6 – 12 months and 1 – 2 years old, respectively.

Surprisingly, there are some mothers confessing that they fed their infants with condensed milk[6] (0.25%) before their infants reach 6 months of age. Further, some mothers acknowledges that they had given their children condensed milk (1.27%)

[3] Infant formula: "a product based on milk of cows or other animals and/or other ingredients which have been proven to be suitable for infant feeding" (Koletzko et al. 2005: 586)
[4] Similar to infant formula but specified for infant above 6 months till one year, some nutrition content is adjusted to fulfill the requirement of babies above 6 months of age
[5] Child milk powder is a product produced by formulated and spray dried the milk which formulated in a way that the nutrition composition suitable for targeted consumer (CODEX STAN 206-1999*1*).
[6] Condensed milk is a product resulted by adding extra sugar and condensing it by using evaporation (CODEX STAN 206-1999*1*).

and/or reconstituted milk[7] (0.17%) before their infants reach one year of age. Indeed, during this period, especially before 6 months of age, only breast milk and infant formula which are the only suitable food for them since their digestive tract is not yet fully developed. Some mothers also testify that their infants got indigestion after this improper feeding practice.

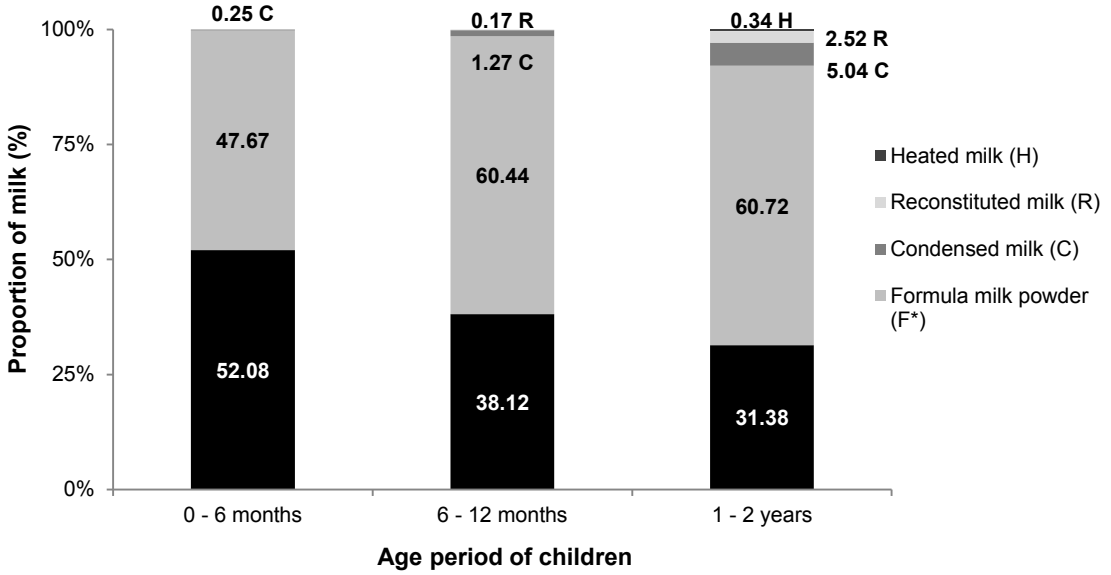


Figure 4.1 Proportion of milk intake of respondents from birth to two years of age in Bogor – Indonesia

Note: F*: infant formula for 0 – 6 months, follow-on formula for 6 – 12 months, child milk powders for above one year old. Data was extracted from milk frequency (ml/day). Proportion of milk (%): total intake of specific milk per total milk intake, averaged from all respondents (N = 221) in % v/v (ml/ml).

The comparison of nutritional content of infant formula, follow-on formula, reconstituted milk, and condensed milk compared to the whole milk, human milk and WHO standard for infant formula is presented in the **Table 4.3**. The all following nutritional content was calculated for 100ml milk. As the breast milk substitute, infant formula is constructed to mimic human milk. Therefore, the main nutritional composition between them is very much similar. There were no other milks suitable for infant age 0 – 6 months except breast milk and its substitute if the breast milk is not available which habitually called as infant formula. The other milks are not suitable for young infant since the kidney of young infant is not yet fully developed. Other milks typically contain higher amount of protein with higher proportion of rennet form so that is too heavy for their digestion. That is why some respondents ever got indigestion problem after consuming

[7] Reconstituted milk is a dairy product obtained by addition of water to the dried or concentrated form of milk in order to produce anappropriate water to solids ratio of milk product (CODEX STAN 206-1999*1*).

condensed and/or reconstituted milk which contain higher protein intake during their infancy.

There are 10 infant formula brands available in the market and consumed by the respondents. The main characteristics of infant formula are low content of protein (about 1.25 g/100ml) and higher carbohydrate content (about 7.4 g/100ml) compared to the cow milk. This is addressed to get close to human milk and be acceptable for young infant. Infant formula contains high micronutrients, i.e. two to five folds than the human milk. This is because of three main reasons, those are (1) give additional benefit; (2) encounter the low availability of the micronutrients contained in formula milk; and (3) anticipate the potential losses during treatment, transportation, and storage (Koletzko et al. 2005: 593ff). However, the bioavailability of each nutrient of the formula is urgently to be examined for ensuring the best formula for infant.

The total energy content of these milks varied from 60 to 70 kcal/100ml. Only follow-on formula, powdered milk for age 1–3, powdered milk for above 3 years old, and condensed milk contained more than 70 kcal, i.e. 72, 85.3, 88.6 and 76.4 kcal/100ml, respectively. These higher energy contents are particularly from higher carbohydrate contents, i.e. 8.6, 11.4, 11.6, 13.1 g/ml respectively. Follow-on formula contains higher amount of protein (2.2 g/100ml) and carbohydrate (8.6 g/100ml) than the infant formula. However, these nutritional characteristics are intended to make the formula appropriate for young infant, infant formula for 0 – 6 months when the digestion not yet fully ready for high protein content and follow-on formula for 6 – 12 months of age when the infant became more active.

Table 4.3 Comparison of nutritional composition of whole milk, human milk, WHO standard for infant formula, infant formula, follow-on formula, powdered milk, reconstituted milk, condensed milk and heated milk

Composition per 100ml	Unit	Whole milk*	Human milk (mature)*	WHO standard for infant formula	Result from basket survey						
					Infant formula	Follow-on formula	Powdered milk		Recons-tituted milk	Condensed milk	Heated milk
				0 – 6 m	0 - 6 m	7 - 12 m	1 - 3 y	> 3 y	> 1 y	> 1 y	> 1 y
N		801	3027	Min – Max	10	15	19	23	8	8	4
Total energy	kcal	66.00	66.78	60 – 70	67.00	72.00	85.28	88.65	69.75	76.39	63.49
Energy from fat	kcal	29.63	31.84	26.1 – 36	31.22	28.75	27.05	28.94	14.94	19.44	31.75
Macronutrients											
Protein	g	3.20	0.95	1.2 – 2.0	1.25	2.20	2.94	3.30	2.57	1.11	3.17
Fat	g	3.30	3.55	2.9 – 4.0	3.48	3.20	2.91	3.31	2.19	2.15	3.70
Saturated fat	g	2.40	1.43	na	1.40	na	0.94	1.35	1.46	1.04	2.65
Unsaturated fat	g	2.20	2.20	na	1.90	na	1.97	3.33	0.79	1.25	na
Cholesterol	mg	14.00	16.00	na	6.00	6.00	6.38	6.15	4.88	1.11	13.23
Carbohydrate	g	4.80	7.20	6.0 – 9.4	7.43	8.60	11.44	11.61	9.87	13.06	4.76
Total sugars	g	4.80	7.20	na	na	na	8.84	7.53	na	11.11	na
Lactose	g	5.30	7.29	3.0 – N/S	na	7.00	6.52	7.36	na	Na	na
Dietary fiber	g	na	na	na	na	0.20	0.57	0.79	1.05	0.83	na
Sucrose	g	na	na	na	na	0.88	2.32	3.67	7.14	10.83	na
Fructose	g	na	na	na	na	na	na	0.43	na	na	na
Glucose	g	na	na	na	na	na	1.96	2.17	na	na	na
Isomaltulosa	g	na	na	na	na	na	1.50	1.50	na	na	na

Note: * Meta-analysed from Ballard and Morrow 2013, Shi et al. 2011, and Hambraeus 1984; Infant formula: "a product based on milk of cows or other animals and/or other ingredients which have been proven to be suitable for infant feeding" (Koletzko et al. 2005: 586); Follow-on formula: Similar to infant formula but specified for infant above 6 months till one year, some nutrition content is adjusted to fulfill the requirement of babies above 6 months of age; Powdered milk: a product produced by formulated and spray dried the milk which formulated in a way that the nutrition composition suitable for targeted consumer (CODEX STAN 206-1999*1*); Reconstituted milk is a dairy product obtained by addition of water to the dried or concentrated form of milk in order to produce anappropriate water to solids ratio of milk product (CODEX STAN 206-1999*1*); Condensed milk is a product resulted by adding extra sugar and condensing it by using evaporation (CODEX STAN 206-1999*1*); N: number of samples; m: month; y: year; na: data is not available.

Continuation of Table 4.3 Comparison of nutritional composition of whole milk, human milk, WHO standard for infant formula, infant formula, follow-on formula, powdered milk, reconstituted milk, condensed milk and heated milk

Composition per 100ml	Unit	Whole milk	Human milk (mature)	WHO standard for infant formula	Result from basket survey						
					Infant formula	Follow-on formula	Powdered milk		Reconstituted milk	Condensed milk	Heated milk
				0 – 6 m	0 - 6 m	7 - 12 m	1 - 3 y	> 3 y	> 1 y	> 1 y	> 1 y
Micronutrients											
A	µg*	28.00	20.40	40 – 121	50.57	108.20	87.85	84.59	63.44	73.75	na
D	µg	0.03	0.20	0.67 – 1.68	0.93	10.00	7.44	4.64	1.63	0.72	na
E	mg	0.06	0.23	0.34 – 3.35	0.78	0.59	0.96	0.79	0.46	1.14	na
K	µg	na	0.01	2.68 – 16.75	8.40	7.90	3.96	2.36	2.82	Na	na
C	mg	1.00	1.60	6.7 – 20.1	7.68	9.90	9.95	6.75	2.00	3.00	na
B1 (Thiamine)	mg	0.04	0.01	0.042 – 0.201	0.06	0.07	0.09	0.08	0.10	0.17	na
B2 (Riboflavin)	mg	0.18	0.01	0.054 – 0.268	0.10	0.11	0.14	0.10	0.10	0.11	na
B3 (Niacin)	mg	0.10	0.18	0.201 – 1.005	0.44	0.49	1.05	0.97	1.03	0.89	na
B5 (Pantothenic acid)	mg	0.35	0.25	0.268 – 1.340	0.33	0.34	0.39	0.33	0.28	Na	na
B6 (Piridoxine)	mg	0.06	0.0046	0.023 – 0.117	0.03	0.05	0.09	0.07	0.14	0.11	na
B9 (Folic acid)	µg	5.00	2.40	6.7 – 33.5	8.60	10.54	31.80	23.32	25.08	Na	na
B12 (Cobalamine)	µg	0.44		0.07 – 0.34	0.13	0.15	0.33	0.70	0.19	0.22	na
Ca	mg	110.00	33.40	34 – 94	38.33	73.40	109.15	110.18	156.72	43.61	na
Fe	mg	0.05	0.05	0.2 – 0.87	0.57	0.95	0.20	0.92	0.25	Na	na
Zn	mg	0.40	0.20	0.34 – 1.0	1.71	0.52	1.00	0.93	0.89	Na	na
Mg	mg	10.00	3.70	3.35 – 10	5.35	6.82	9.80	6.64	8.05	9.72	na
P	mg	92.00	16.70	16.8 – 60.3	21.20	38.78	86.95	66.77	167.52	34.44	na
I	µg	15.00	27.90	6.7 – 33.5	9.20	12.26	16.83	15.82	7.92	Na	na
Se	µg	3.70	1.50	0.67 – 6.0	1.18	1.54	2.50	2.05	1.00	Na	na
Ca/P		1.20	2.00	2.02 – 1.56	1.81	1.89	1.26	1.65	0.94	1.27	na
Na	mg	55.00	13.80	13.4 – 40.2	18.45	34.00	45.36	60.36	43.74	33.33	60.85
K	mg	140.00	50.40	40.2 – 107.2	61.55	89.90	139.73	174.22	160.77	84.26	na

Note: * Meta-analysed from Ballard and Morrow 2013, Shi et al. 2011, and Hambraeus 1984; Infant formula: "a product based on milk of cows or other animals and/or other ingredients which have been proven to be suitable for infant feeding" (Koletzko et al. 2005: 586); Follow-on formula: Similar to infant formula but specified for infant above 6 months till one year, some nutrition content is adjusted to fulfill the requirement of babies above 6 months of age; Powdered milk: a product produced by formulated and spray dried the milk which formulated in a way that the nutrition composition suitable for targeted consumer (CODEX STAN 206-1999*1*); Reconstituted milk is a dairy product obtained by addition of water to the dried or concentrated form of milk in order to produce anappropriate water to solids ratio of milk product (CODEX STAN 206-1999*1*); Condensed milk is a product resulted by adding extra sugar and condensing it by using evaporation (CODEX STAN 206-1999*1*); N: number of samples; m: month; y: year; na: data is not available.

4.1.3.2 Childhood

From the survey among children living in Bogor, in addition to the breast milk, it can be observed that there are four types of milk that are commonly consumed by children above 1 year old, those are child powdered milk, reconstituted milk, condensed milk, and heated milk.

The current usual daily milk intake of the beneficiaries calculated by using Multiple Source Methods (MSM) is 258.3 ml/day (**Figure 4.2**). The powdered milk places the majority portion (135.9 ml/day), followed by sweetened condensed-, reconstituted-, and heated- milk; 59.4, 59.2, and 2.2 ml/day respectively. From the average value (258.3 ml/day), it seems that the milk intake among Indonesian children satisfy only a half of the international recommendation on milk intake. The recommended portion is 550 ml of low fat milk per day to meet daily intake 700 mg of calcium. But according to the survey, the gap among the respondent is very large, that is from 0 to 1651 ml/day. It is reported that as many as 9 children from 221 respondents (4.1%) never drink any kind of milk during age 5 to 6 years. And 8 children (3.6%) usually consume more than 750 ml/day, even three of them usually consume more than one Littre of milk per day.

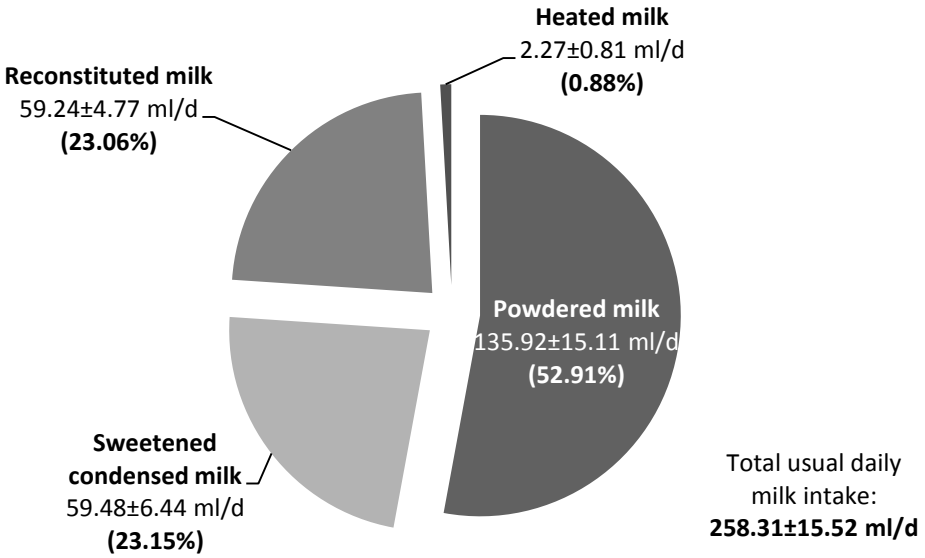


Figure 4.2 Usual daily milk intake of children age 5 - 6 years old in Bogor – Indonesia

Note: The presented value is the mean value of usual daily milk intake ± standard error calculated by using MSM (Multiple Source Method)

However, from the current assessment of usual daily milk intake, it is recognized that majority of the children (92.3%) consume less than 550 ml milk/day. The result shows that 38.5% of respondent consume less than 125 ml/day, 19.4% consume about one portion of milk per day (125 – 250 ml/day), 34.4% consume almost two portion of milk per day (250 – 550 ml/day), and only 7.7% who consume more than 550 ml/day.

Figure 4.3 illustrates the milk consumption proportion of the respondent represent children who live in Bogor from age 0 to 6 years of age. The portion of breast milk is reduced during the second year of the respondent life, it places 31.4%. The rest is covered by powdered-, condensed-, reconstituted-, and heated- milk, 60.72, 5.04, 2.52, and 0.34% respectively. The consumption portion of these four milks increase during their following age. Powdered milk places the majority portion, 66.9% on period 2 till 4 years old, and 49.6% on period 4 till 6 years old.

Condensed milk places about 22% during period 2 till 6 years old. Three respondents confessed that they had breast feed their children till five years old. But the portion is not included on the graphic due to the unknown quantity. Reconstituted milk places 10.3% on 2 till 4 years old. And it was significantly increased during period 4 till 6 years old, places 21.6%. This was because its convenience for outdoor consumption during their school time. Age 4 till 6 years old is the period when they start to join a pre-school education program. Heated milk places only small portion, about 1%. Although heated milk serve best in delivering the nutrition due to the minimum nutrient loss during the manufacturing, but it less famous among the respondents. This was because the high price and less convenience for carrying and for storage. Heated milk becomes more perishable in Indonesia as a tropical country. And the majority of Indonesians do not have a refrigerator at home.

The powdered milk has additional benefits that is its convenience in preparation and storage, if it is compared to the heated milk. Refrigeration is not needed to store the powdered milk. Due to the economic constraint, the refrigerator is not popular among Indonesian. Therefore, powdered milk, reconstituted milk with “tetra pack” packaging technology, and condensed milk are more popular among Indonesian, compared to the heated milk (pasteurized and sterilized milk).

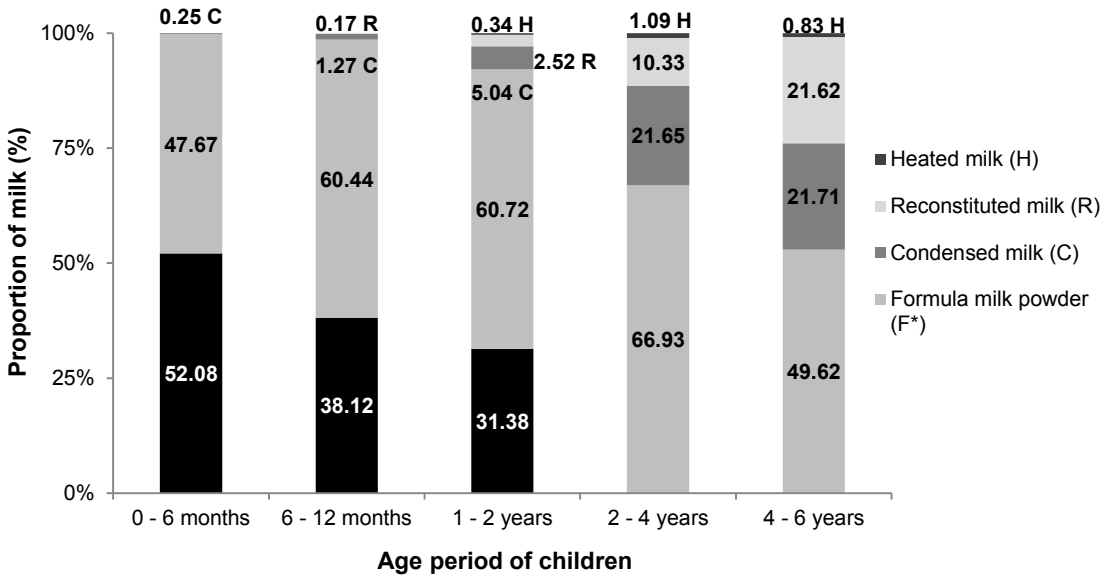


Figure 4.3 Proportion of milk intake of respondents from birth to six years of age in Bogor – Indonesia

Note: F*: infant formula for 0 – 6 months, follow-on formula for 6 – 12 months, child milk powders for above one year old. Data was extracted from milk frequency (ml/day). Proportion of milk (%): total intake of specific milk per total milk intake, averaged from all respondents (N = 221) in % v/v (ml/ml).

4.1.3.3 Milk market share

From the above description, Indonesia provides a great market for commercial milks for children. Among those milk products, powdered milk places the majority portion in Indonesia. There are abundant milk producers contribute to share in this market. From the current study (**Figure 4.4**), it is counted that Nestle and Sari Husada share the majority market place by 48.2% and 30.4%, respectively. Then they followed by Frisian Flag, Nutricia and Abbott, with 9.5%, 8% and 1.4%, respectively. The rest 2.5% market are placed by Kalbe, Mead Johnson, Wyeth and others.

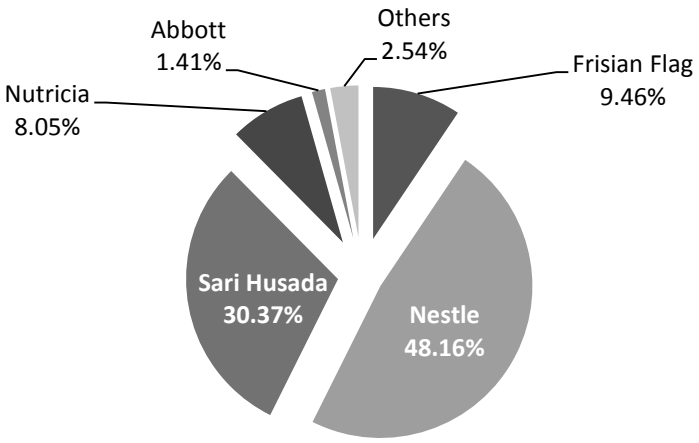


Figure 4.4 Main producer of powdered milk in Indonesia
Source: Own resource

4.1.3.4 Nutritional quality of the milk products

The comparison of nutritional composition of those milks compared to the whole milk, human milk, and infant formula WHO standard is presented in **Table 4.3**.

According to the nutritional composition, the powdered milk is formulated to be closed to the nutritional need, Dietary Reference Intake (DRI) of the intended child group. Whereas, heated milk, reconstituted milk, and condensed milk have wider range of consumer age (above one year) compared to the powdered milk which focus on the selected age, for instance 1 – 3 and 3 – 6 years of age.

From this basket survey, it is shown that the reconstituted milk available in the market compared to the cow´s milk typically has lower fat content (2.5g/100ml) but higher carbohydrate content (9.87g/100ml) which mostly coming from sucrose (7.14g/100ml). While the condensed milk has uniqueness on lower protein (1.1g/100ml) and fat (2.15g/100ml) content and much higher carbohydrate content (13.1g/100ml) which mostly coming from sucrose (11.1g/100ml) compared to the cow´s milk (4.8g/100ml).

However the nutritional quality evaluation by using basic nutritional value is not able to satisfy the deep insight on the nutritional quality of the foods. In the following view, it is investigated the second upper level of nutritional quality evaluation technique, namely nutrient density approach. This approach is the extension of the constituent approach which focuses on the nutrient density of the foods (Drewnowski 2005: 721; Miller et al.

2009: 1198). NNR or "Naturally Nutrient Rich score" is one option for this approach, NNR is the nutritional evaluation using nutrient density approach which calculated from the average of ratio contribution of about 16 selected compounds from food products which contain the same level of kcal energy from Dietary Reference Intake (DRI) to cover the DRI of the selected key nutrients. NNR score of the commonly consumed milk by the respondents using DRI for children age 1 – 3 years and 4 – 6 years is presented in **Table 4.4** and **4.5** respectively. Unsaturated fatty acids are excluded from the assessment due to unavailable information.

Table 4.4 Naturally Nutrient Rich (NNR) score of some milk products consumed by children using DRI 1 – 3 years of age

Nutrient	AKG 1 - 3 y		Heated milk		Powdered milk		Reconstituted milk	Condensed milk
			3.5% fat	1.5% fat	1 - 3 y	> 3 y	> 1 y	> 1 y
Energy	1125	kcal						
Protein	26	g	2.10	2.79	1.49	1.61	1.59	0.63
Vitamin								
A	400	mcg	1.19	0.34	2.90	2.68	2.56	2.70
D	15	mcg	0.03	0.09	6.54	3.93	1.75	0.70
E	6	mg	0.17	0.00	2.11	1.67	1.24	2.79
C	40	mg	0.43	0.75	3.28	2.14	0.81	1.10
B1	0.6	mg	1.14	0.47	1.98	1.69	2.69	4.15
B2	0.7	mg	4.38	5.34	2.64	1.81	2.30	2.30
B3	6	mg	0.28	na	2.31	2.05	2.77	2.17
B6	0.5	mg	2.05	na	2.37	1.78	4.52	3.22
B5	2	mg	2.98	1.50	2.57	2.09	2.26	0
B12	0.9	mcg	8.33	7.50	4.84	9.87	3.41	3.58
Mineral								
Ca	650	mg	2.88	3.83	2.22	2.15	3.89	0.98
Zn	4	mg	1.70	2.60	3.30	2.95	3.59	0
Fe	8	mg	0.11	0.00	0.33	1.46	0.50	0
K	3000	mg	0.80	1.44	0.61	0.74	0.86	0.41
Mg	60	mg	2.84	na	2.15	1.40	2.16	2.37
NNR			**1.96**	**2.05**	**2.60**	**2.50**	**2.31**	**1.69**

Note: NNR is the nutritional evaluation using nutrient density approach which calculated from the average of ratio contribution of 16 selected componds from milk products which contain 1125 kcal energy (DRI of energy for children age 1 – 3 years old) to cover the Dietary Reference Intake (DRI) children age 1 – 3 years old; na: the information is not available.

Assessment of NNR score using DRI for children age 1 – 3 years demonstrates that powdered milk for age 1-3 years old, powdered milk for age above 3 years old, and reconstituted milk have the highest NNR score, i.e. 2.6, 2.5 and 2.3 respectively. Heated milk 3.5 and 1.5% fat are plotted at the middle place, i.e. 1.96 and 2.1 respectively. And the condensed milk is plotted on the lowest score, i.e. 1.7.

Similar NNR score pattern is shown from NNR calculation using DRI for children age 4 – 6 years old (**Table 4.5**), where the powdered- and reconstituted milk places the highest score, followed by heated milk at the middle place, and then the condensed

milk placed the last score.

Table 4.5 Naturally Nutrient Rich (NNR) score of some milk products consumed by children using DRI 4 – 6 years of age

Nutrient	AKG 4 - 6 y		Heated milk		Powdered milk		Recons-tituted milk	Con-densed milk
			3.5% fat	1.5% fat	1 - 3 y	> 3 y	> 1 y	> 1 y
Energy	1600	kcal						
Protein	35	g	2.22	2.95	1.58	1.70	1.68	0.66
Vitamin A	450	mcg	1.51	0.43	3.66	3.39	3.23	3.42
Vitamin D	15	mcg	0.05	0.13	9.31	5.58	2.49	1.00
Vitamin E	7	mg	0.21	0.00	2.57	2.04	1.51	3.40
Vitamin C	45	mg	0.54	0.95	4.15	2.71	1.02	1.39
Vitamin B1	0.8	mg	1.21	0.50	2.11	1.80	2.87	4.43
Vitamin B2	1	mg	4.36	5.32	2.63	1.80	2.29	2.29
Vitamin B3	9	mg	0.27	Na	2.19	1.95	2.63	2.06
Vitamin B6	0.6	mg	2.42	Na	2.81	2.11	5.35	3.82
Vitamin B5	2	mg	4.24	2.13	3.66	2.98	3.21	0.00
Vitamin B12	1.2	mcg	8.89	8.00	5.16	10.53	3.63	3.82
Ca	1000	mg	2.67	3.54	2.05	1.99	3.60	0.91
Zn	5	mg	1.94	2.95	3.75	3.36	4.08	0.00
Fe	9	mg	0.13	0.14	0.42	1.84	0.64	0.00
Kalium	3800	mg	0.89	1.62	0.69	0.83	0.97	0.46
Mg	95	mg	2.55	Na	1.94	1.26	1.94	2.13
NNR			**2.13**	**2.20**	**3.04**	**2.87**	**2.57**	**1.86**

Note: NNR is the nutritional evaluation using nutrient density approach which calculated from the average of ratio contribution of 16 selected key compounds from milk products which contain 1600 kcal energy (DRI of energy for children age 4 – 6 years old) to cover the Dietary Reference Intake (DRI) children age 4 – 6 years old.

However, the majority of micronutrients contain in powdered-, reconstituted-, and condensed- milk are derived from fortification instead of occurring naturally. When taking this aspect of naturalness into account, surely that heated milk become the best option as the food complement after the children weaned from the breast milk. This examination then places the condensed milk into the last option to be offered to the children above one year.

Therefore, taking the fortification matter into account, further assessment on the “real” bioavailability of each nutrient is urgently demanded so that one is able to give better insight of nutritional quality of those milks. Moreover, the effect of high ratio NNR score (4 till 10) of some nutrients also need further investigation to gather a better view whether this high score might induce some adverse effects or not. Furthermore, the unavailable information regarding the content of unsaturated fat on the product makes the current nutritional evaluation limited and need further adjustment for better insight. However, from the aspect of convenience on transporting, storage, and preparing in tropical area, powdered milk becomes the excellent choice as the food complement after the weaning period.

As the comparison, the NNR score of some other foods which are commonly consumed by the respondents is also calculated and viewed in **Table 4.6**. To get better comparison, it is calculated the NNR score per portion. This is done since the food intake capacity of the children quite limited and diverse among the foodstuffs. The assessment reveals that milk on average has the highest value of NNR score per portion (0.21) compared to the other foods (0.03 – 0.14). This indicates that at the normal portion, milk is able to deliver higher amount of nutrients per kcal energy compared to other foods. Therefore, as a nutrient dense food, milk is potentially become a "transportation" to deliver a lot of essential compounds into the body. Current assessment, it was proved that milk is the most nutrient dense food for beneficiaries, which at the same energy level milk contain higher nutrients compared to other foods.

Table 4.6 Naturally Nutrient Rich (NNR) score of some other foods which commonly consumed by the respondents using DRI children age 4 to 6 years old

Foods commonly consumed	NNR score*	Quantity per portion	NNR load		NNR score per portion**
			Total weight	Number of portion	
Heated milk (3.5% fat)	2.13	180 ml	2424.24	13.5	0.16
Heated milk (1.5% fat)	2.20	180 ml	2520.08	14.0	0.16
Powdered milk (1 - 3 y)	3.04	180 ml	1876.17	10.4	0.29
Powdered milk (> 3 y)	2.87	180 ml	1804.85	10.0	0.29
Reconstituted milk (> 1 y)	2.57	180 ml	2293.91	12.7	0.20
Condensed milk(> 1 y)	1.86	180 ml	2094.51	11.6	0.16
Average value from milk available for child above one year	**2.45**	**180 ml**	**2085.78**	**11.6**	**0.21**
Nasi (cooked rice)	0.56	75 g	1230.77	16.4	0.03
Sayur bayam (Spinach soup)	21.30	50 g	13333.33	266.7	0.08
Ceplok telur (Fried egg)	1.54	58 g	631.35	10.8	0.14
Fried chicken	1.92	50 g	747.66	15.0	0.13
Tempe goreng (Fried tempe)	1.17	50 g	476.19	9.5	0.12
Tahu goreng (Fried tofu)	0.98	50 g	769.23	15.4	0.06
Fried instant noodle	0.95	42.5 g	357.89	8.4	0.11
Carrot fresh cooked	19.87	20 g	7619.05	381.0	0.05
Chicken nugget	0.91	50 g	727.27	14.5	0.06
Manggo	4.65	47.7 g	2654.61	55.7	0.08
Fried sausage	0.84	40 g	711.11	17.8	0.05
Roti coklat	0.47	56.8 g	64.47	9.9	0.05
White wheaten bread	0.43	40 g	680.85	17.0	0.03
Meat balls	1.79	50 g	1290.32	25.8	0.07

Note: NNR is the nutritional evaluation using nutrient density approach which calculated from the average of ratio contribution of 16 selected key compounds from foods which contain 1600 kcal energy (DRI of energy for children age 4 – 6 years old) to cover the Dietary Reference Intake (DRI) children age 4 – 6 years old; NNR score*: calculated from foods contained 1600 kcal energy; Quantity per portion: normal amount of food per child portion; NNR load: amount of food to fulfil 1600 kcal energy; NNR score per portion**: calculated from the average of ratio contribution of 16 selected key compounds from each portion of foods.

4.2 Double burden malnutrition and some brain development indicators

The correlation of feeding behaviour, nutritional intake and cognitive development are always interesting to be evaluated. **Table 4.7** is described the socioeconomic characteristics of the respondents included for study the relationship of nutritional status and some brain development indicators. A total of 387 respondents, 202 boys and 185 girls, were included to gather best representative number of children per each nutritional category, i.e. SAM (N = 60), MAM (N = 61), normal (N = 163), overweight (N = 43), and obesity (N = 60).

Table 4.7 Characteristics of children and their household from the second batch of study

Characteristics	N	%
Survey location (respondents)		
Bogor city	199	51.42
Bogor Selatan	38	9.82
Bogor Tanah Sareal	76	19.64
Bogor Barat	24	6.20
Bogor Utara	61	15.76
Bogor Regency	188	48.58
Desa Bojong Baru, Kecamatan Bojong Gede	31	8.01
Desa Gunung Sari, Kecamatan Pamijahan	79	20.41
Desa Karadenan, Kecamatan Cibinong	29	7.49
Desa Babakan, Kecamatan Darmaga	49	12.66
Total of respondents	387	
Child's sex (respondents)		
Male	202	52.20
Female	185	47.80
Mother's education (respondents)		
≤ 6th grade	66	17.05
6th - 9th grade	60	15.50
Completed high school	113	29.20
Some post secondary	61	15.76
Completed bachelor degree	64	16.54
Completed master degree	23	5.94
Mother's occupation (respondents)		
Housewife (full time at home)	241	62.27
Half time working	42	10.85
Full time working	104	26.87
Father's education (respondents)		
≤ 6th grade	46	11.89
6th - 9th grade	56	14.47
Completed high school	127	32.82
Some post secondary	56	14.47
Completed bachelor degree	67	17.31
Completed master degree	35	9.04
Household members		4.4±0.1
Birth order		2.1±0.1

Continuation of Table 4.7 Characteristics of children and their household from the second batch of study

Characteristics	N	%
Household income (USD/month)		573.0±32.8
Minimum – maximum		30.00 – 7,000,00
< 100	27	6.98
100 – 299	115	29.72
300 – 499	83	21.45
500 – 999	98	25.32
≥ 1000	64	16.54
Income per capita (USD/month)		132.7±7.2
Minimum – maximum		10.00 – 1,400.00
< 20	29	7.49
20 – 49	81	20.93
50 – 99	109	28.17
100 – 249	128	33.07
≥ 250	40	10.34
Expenditure on food (USD/month)	225.0±8.8	
Main food	156.0±7.3	
Snack	43.2±2.3	
Milk	29.0±2.0	

Note: USD: US Dollar (assumption 1 USD equal to 10 000 IDR); IDR: Indonesian Rupiah

Exclusive- vs non exclusive- breast feed

The grouping of the respondent according to whether they received exclusive breast feeding or not reveals that the children who received exclusive breast feeding has significantly higher emotional quotient (370.3) compared to the children who did not received (353.9) (see **Table 4.8**). No other significant result is shown for other cognitive results (IQ, memory-, attention-, and learning- ability, see **Table 4.8**).

Under- and over- nourished children

Moreover, from the current study, it is revealed that the memory ability score of normal children is significantly (P-value < 0.05) higher (52.4) compared to the malnourished children, both under- and over- nourished children (SAM = 45.2; MAM = 48.5; overweight = 48.4; obesity = 47.9; **Table 4.9**; **Figure 4.5**). The IQ score tended (P-value < 0.1) to be higher on normal children (106.7) than the malnourished children, both under- and over- nourished children (SAM = 106.5; MAM = 105.2; overweight = 104.7; obesity = 105.2; **Table 4.9**; **Figure 4.6**). No significance different is showed from EQ and learning ability by nutritional status.

Table 4.8 Mean value of cognitive ability (IQ, EQ, memory, attention, and learning) at 5 – 6 years old of children who received- and do not received-exclusive breast feeding

Nutritional status	N	IQ			EQ			Memory			Attention			Learning		
		Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
Non exclusive breast fed	235	105.82	±	0.41	353.95	±	5.06[a]	49.00	±	0.74	36.48	±	0.54	47.20	±	1.77
Exclusive breast fed	152	106.72	±	0.45	370.35	±	4.33[b]	50.29	±	0.96	36.03	±	0.76	46.06	±	2.23
Overall mean	387	106.17	±	0.31	360.23	±	3.55	49.50	±	0.58	36.31	±	0.44	46.76	±	1.38

Note: N: number of respondents; IQ: Intelligence Quotient; EQ: Emotional Quotient; BMI: body mass index; calculated as kg/m2; BMIfAz: BMI-for-Age z-score; Mean: mean value; SE; Strandard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

Table 4.9 Mean value of cognitive ability (IQ, EQ, memory, learning) by nutritional status (SAM, MAM, normal, overweight and obesity)

Nutritional status	BMIfAz	N	IQ			EQ			Memory			Learning		
			Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
SAM	< -3	60	106.46	±	0.61[ab]	376.35	±	4.16	45.22	±	1.33[a]	50.16	±	3.62
MAM	-2 < z ≤ -3	61	105.23	±	0.59[ab]	369.88	±	4.51	48.55	±	1.48[a]	48.55	±	3.55
Normal	-2 ≤ z ≤ 1	163	106.69	±	0.45[b]	366.59	±	2.86	52.42	±	0.88[b]	44.02	±	2.08
Overweight	1 < z ≤ 2	43	104.72	±	0.67[a]	320.06	±	17.70	48.44	±	1.44[a]	48.08	±	3.52
Obesity	> 2	60	105.22	±	0.68[ab]	334.76	±	13.28	47.95	±	1.32[a]	47.41	±	3.26
Overall mean		387	106.17	±	0.31	360.23	±	3.55	49.50	±	0.58	46.76	±	1.38

Note: BMI: body mass index; calculated as kg/m2, SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; BMIfAz: BMI-for-Age z-score; IQ: Intelligence Quotient; EQ: Emotional Quotient; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

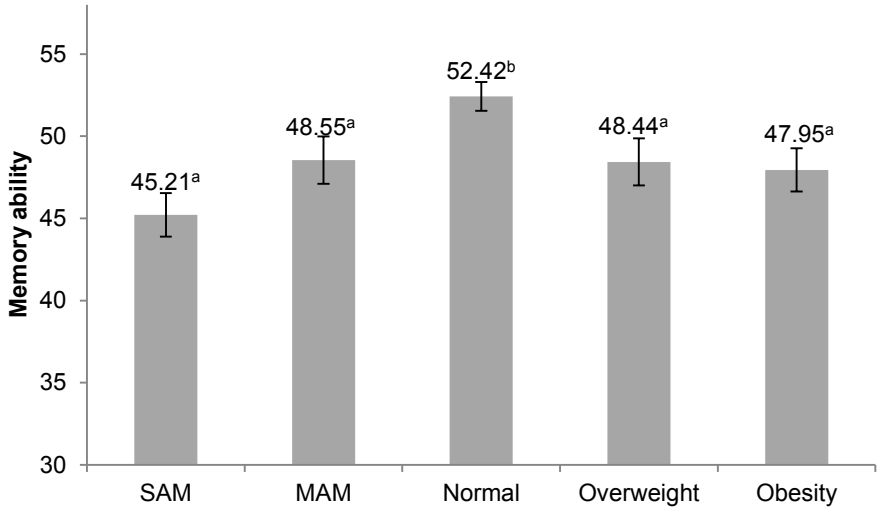


Figure 4.5 Memory ability score by nutritional status (SAM, MAM, normal, overweight and obesity)

Note: SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

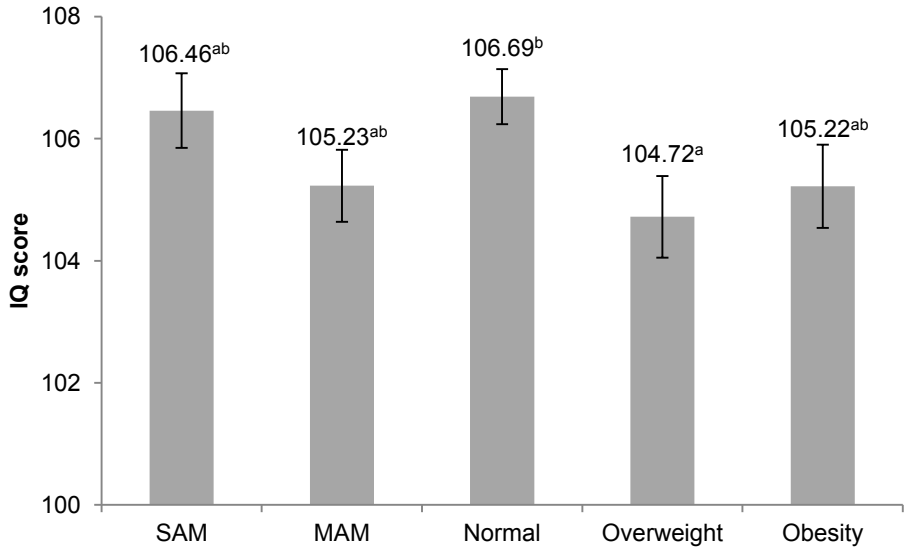


Figure 4.6 IQ score by nutritional status (SAM, MAM, normal, overweight and obesity)

Note: SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

Boys vs girls

Interesting result is shown from attention ability test. By grouping the result of cognitive ability test by sex does not provide any significant differences except for attention ability. In overall mean value, the girls significantly have higher attention ability score

(37.9) than the boys (35.4) (P-value < 0.01). Further grouping according to the nutritional status reveals that the nutritional status of preschool children has a strong linkage with their attention ability. Either boys or girls, undernourished children have significantly (P-value < 0.05) lower attention ability score (SAM boys = 33.7; MAM boys = 32.2; SAM girls = 33.5; MAM girls = 36.6) compared to the normal children (boys = 36.5; girls = 38.5). The effect was higher on boys than on girls. There is no significant difference detected from comparing overnourished- and normal- children (**Table 4.10**).

As a sub conclusion, according to the above evaluation and analysis, it can be concluded that either under- or over- nutrition significantly influence the cognitive performance of the children, particularly their memory ability. Exclusive breast feeding practice proved significantly to effect on enhancing the emotional quotient of the children.

Table 4.10 Mean value of attention ability by sex and nutritional status (SAM, MAM, normal, overweight and obesity)

Nutritional status	BMI-for-Age z-score	Boys					Girls					P-value	
		N	%	Mean	±	SE	N	%	Mean	±	SE		
SAM	< -3	29	14.72	33.77	±	1.19^{ab}	24	12.02	33.59	±	1.45^{x}	0.852	ns
MAM	-2 < z ≤ -3	33	16.75	32.21	±	1.49^{a}	28	14.75	36.63	±	1.27^{xy}	0.034	*
Normal	-2 ≤ z ≤ 1	72	36.55	36.26	±	0.86^{b}	83	44.81	38.53	±	0.86^{y}	0.027	*
Overweight	1 < z ≤ 2	28	14.21	36.68	±	1.52^{b}	25	13.11	39.63	±	1.43^{y}	0.174	ns
Obesity	> 2	35	17.77	37.29	±	1.20^{b}	30	15.30	39.07	±	1.65^{y}	0.358	ns
Overall mean		197	100	35.46	±	0.54	190	100	37.92	±	0.57	0.004	**

Note: BMI: body mass index; calculated as kg/m2, SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; z: BMI-for-Age z-score; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test; ns: not significant; *: P-value<0.05; **: P-value<0.01; ***: P-value<0.001.

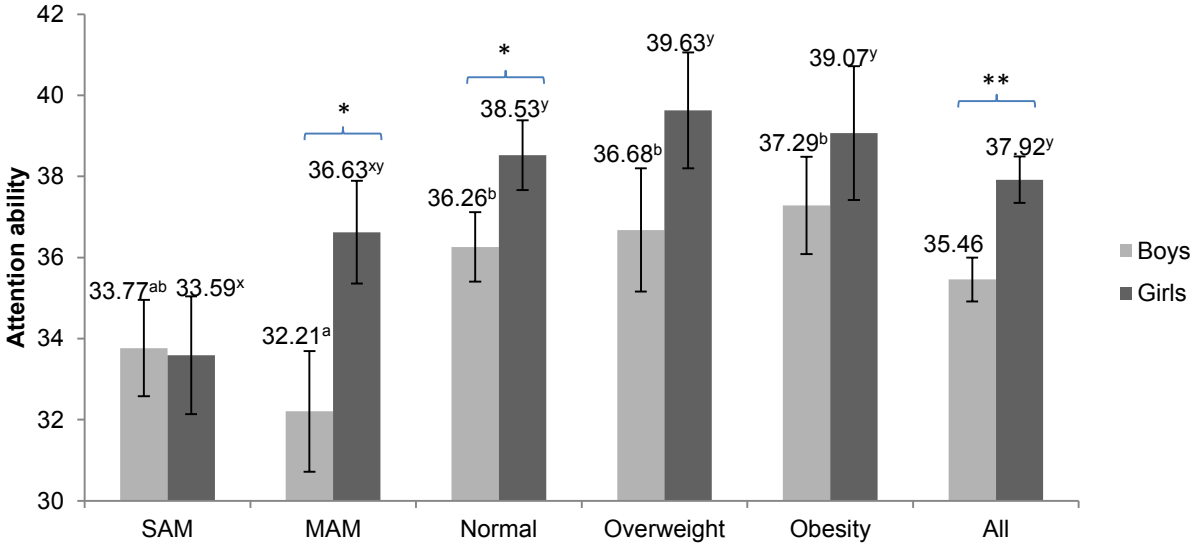


Figure 4.7 Attention ability score by sex and nutritional status (SAM, MAM, normal, overweight and obesity)

Note: SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test; ns: not significant; *: P-value<0.05; **: P-value<0.01; ***: P-value<0.001.

4.3 Double burden malnutrition, socioeconomic status, and milk consumption

Current study demonstrates that Indonesia is facing double burden of malnutrition where the problem of child undernutrition remains high and unsolved and the child overnutrition is emerging. This study also reveals that both child under- and over-nutrition indeed impair the child cognitive development. The following subsection investigates the linkage between the phenomenon of double burden of child malnutrition with the socioeconomic status (sub section 4.3.1) and milk consumption pattern (sub section 4.3.2).

4.3.1 Socioeconomic status (SES)

Linkage between nutritional status and socioeconomic indicators

To see further correlation of socioeconomic characteristic and children nutritional status, **Table 4.11** presents the average BMI-for-Age z-score of children by their socioeconomic characteristic. The results present that the socioeconomic characteristics of beneficiaries have a strong linkage in affecting child nutrition. Children who live in urban area have better nutritional status than the rural children. Urban children have average BMI-for-Age z-score significantly (P-value < 0.05) higher and above -1 (-0.82) compared to rural children (-1.56). BMI-for-Age z-score -1 is the cut-off point between normal children and moderate acute malnutrition (MAM). The children who live in rural area have an average BMIfAz less than -1 (-1.56). Children who attend formal pre-school education centres also have significantly (P-value < 0.05) better nutritional status (-0.82) compared to children who attend informal pre-school education (-1.55). Children who stay at home and do not attend any pre-school program even have significantly (P-value < 0.05) the lowest nutritional status with BMIfA z-score -2.05.

The Kruskal-Wallis test does not give any significant differences on child nutritional status by maternal education, maternal occupation, paternal education, and capita income. But the pattern seems that mother with better education tend to have better child nutritional status (P-value < 0.1) (see **Table 4.11**). The capita income also shows similar pattern, the higher capita income the better the child nutritional status. While the paternal education and maternal occupation do not show a regular pattern. The cross tab provides better view in this case (**Table 4.11**).

It is obvious that rural area have higher prevalence of child under-nutrition (58.7%) than the urban one (21.6%; **Table 4.11**). But the prevalence of child over-nutrition in urban is higher (16.2%) than in the rural area (4.3%). The larger prevalences of child under-nutrition are also shown in the group of children attained informal pre-school centre (69.2%) and children stay home (88.3%) compared to the children from formal pre-school centre (24.7%).

From prevalence per socioeconomic status, it is shown a pattern that maternal education and capita income have linkages to the child malnutrition (although this pattern is not significant after undertaking Kruskal Wallis-H test). The children from household with less educated mother are more prone to be undernourished (56.6%) than the children with more educated mother (45.8 and 51.7%). But the emerging of child over-nutrition among children from educated mother is stronger (6.9 and 13.79%) than the children from less educated mother (4.2%). Children from higher capita income household are less prone to be undernourished (53.4 and 40.5%) than the children from the lower capita income household (64.5%).

Surprisingly, the children from half time working mothers are more prone to be undernourished (54.4%) compared to the children from full time working mother (45%). This is probably since the half time working mother seems have to divide their time between job and child care. While the full time mothers commonly decide to admit their children into a child care. The prevalence of child under-nutrition from children of full time home mothers seems higher (53.9%) compared to the children from full time working mothers (45%). This probably because the full time working mothers were able to contribute more capita income into their household so that able to ensure the food security in their household. The pattern of the children nutritional status is unclear under the characteristic of paternal education.

Table 4.11 BMI-for-Age z-score and the prevalence (%) of SAM-, MAM-, normal-, overweight-, obese-, under-nutrition, and over-nutrition children by their socioeconomic characteristics

Socioeconomic characteristics	BMIfAz			Nutritional status based on BMI-for-Age z-score					Under-nutrition	Over-nutrition
	Mean	±	SE	SAM	MAM	Normal	Overweight	Obesity		
Location										
Rural	-1.56	±	0.09[a]	29.35	29.35	36.96	2.72	1.63	58.70	4.35
Urban	-0.82	±	0.19[b]	0.00	21.62	62.16	8.11	8.11	21.62	16.22
Child's education										
Formal pre-school	-0.82	±	0.18[c]	11.01	13.76	66.06	5.50	3.67	24.77	9.17
Informal pre-school	-1.55	±	0.09[b]	34.62	34.62	23.08	3.85	3.85	69.23	7.69
Children stay home	-2.05	±	0.19[a]	40.00	48.33	11.67	0.00	0.00	88.33	0.00
Mother's education										
Uncompleted high school	-1.63	±	0.15	25.83	30.83	39.17	1.67	2.50	56.67	4.17
Completed high school	-1.33	±	0.16	23.61	22.22	47.22	2.78	4.17	45.83	6.94
Completed higher education	-1.15	±	0.46	20.69	31.03	34.48	13.79	0.00	51.72	13.79
Mother's occupation										
Housewife (full time home)	-1.45	±	0.09	23.38	30.52	41.56	1.95	2.60	53.90	4.55
Half time working	-1.52	±	0.27	33.33	22.22	40.74	0.00	3.70	55.56	3.70
Full time working	-1.07	±	0.30	22.50	22.50	40.00	12.50	2.50	45.00	15.00
Father's education										
Uncompleted high school	-1.47	±	0.15	22.34	28.72	45.74	2.13	1.06	51.06	3.19
Completed high school	-1.44	±	0.15	27.78	26.67	37.78	2.22	5.56	54.44	7.78
Completed higher education	-1.42	±	0.36	21.62	29.73	37.84	10.81	0.00	51.35	10.81
Income/capita (USD/month)										
< 25	-1.61	±	0.25	35.48	29.03	32.26	0.00	3.23	64.52	3.23
25 – 100	-1.49	±	0.15	23.65	29.73	41.22	2.70	2.70	53.38	5.41
≥ 100	-1.38	±	0.33	19.05	21.43	47.62	9.52	2.38	40.48	11.90

Note: The numbers in the table denote percentage; USD: US Dollar (assumption 1 USD equal to 10 000 IDR); IDR: Indonesian Rupiah; BMI: body mass index; calculated as kg/m2, BMIfAz: BMI-for-Age z-score; SAM: Severe Acute Malnutrition (BMIfAz < -3); MAM: Moderate Acute Malnutrition (-3 ≤ z < -2); overweight: 1 < BMIfAz ≤ 2; obesity: BMIfAz > 2; under-nutrition = SAM + MAM; over-nutrition = over-weight +obesity.

To assess the relative impact of socioeconomic status on child malnutrition, a discriminant analysis was performed. From this analysis, it is evident that the strongest impact on child under-nutrition is capita income and maternal education. The analysis signifies that a unit increase in the capita income raises the BMI-for-Age z-score by 0.760 units. And one unit higher of maternal education increases the BMI-for-Age z-score by 0.691 units. While the analysis on the child over-nutrition, none of the socioeconomic status shows any significant impacts on child over-nutrition. But among those characteristics, maternal occupation has the greatest coefficient discriminant. The full time working mother tend to (P-value < 0.1) increase the BMI-for-Age z-score of the normal children (-1<z<1) by 0.889 units.

Linkage between usual milk intake and socioeconomic characteristics

Analysis on usual daily milk intake by socioeconomic profile (**Table 4.12**) illustrates that milk is classified as an exclusive commodity, which the usual daily intake is influenced by demographic and socioeconomic profile of the consumers. The children in urban area significantly (P-value < 0.05) consume more milk (364.9±46.4^{b}) compared to the children in rural area (238.9±15.9^{a}). The powdered- and reconstituted- milk are significantly (P-value < 0.05) consumed higher in urban than in rural. It can also be proven from the child education characteristics, that the children admitted in formal pre-school significantly (P-value < 0.05) consume more milk (367.9±42.1^{c}) compared to the informal pre-school children (239.7±16.3^{b}) and the children who stay at home (50.2±21.7^{a}).

Maternal education, maternal occupation, paternal education, and income significantly differentiate the usual daily milk intake of their children. The calculation views that the children whose parents did not complete a high school education consume significantly (P-value < 0.05) less milk (<250ml/day) compared to the children whose parents completed high school or higher education. The children whose mothers full time working outside consume significantly (P-value < 0.05) higher milk compared to the children whose mothers are full time or half time at home. The children who live under the poverty line (income per capita <25 USD/capita/month) consume significantly (P-value < 0.05) less milk (136.94 ml/day) compared to other children with income per capita above 25 USD/capita/month.

Table 4.12 Usual daily milk intake (mean ml/d) by socioeconomic profile

Characteristics	Breast milk			Formula milk powder			Condensed milk			Reconstituted milk			Heated milk			Total milk		
	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
	----------Mo--------			----------mL/d----------														
Overall mean	17.02	±	0.68	135.92	±	15.11	59.48	±	6.44	59.24	±	4.77	2.27	±	0.81	258.31	±	15.52
Location																		
Rural	17.44	±	0.75	119.46	±	15.53^{a}	64.05	±	7.28	49.84	±	4.82^{a}	2.08	±	0.90	238.93	±	15.93^{a}
Urban	14.74	±	1.61	226.49	±	46.06^{b}	34.37	±	11.31	110.95	±	13.08^{b}	3.35	±	1.69	364.90	±	46.44^{b}
Child's education																		
Formal pre-school	14.95	±	1.47	230.92	±	43.04^{c}	34.41	±	10.35	110.04	±	12.27^{b}	3.00	±	1.52	367.89	±	42.13^{c}
Informal pre-school	17.33	±	0.78	118.80	±	15.87^{b}	65.24	±	7.58	49.31	±	4.92^{a}	2.04	±	0.93	239.70	±	16.35^{b}
Children stay home	23.00	±	4.36	0.00	±	0.00^{a}	40.06	±	16.92	20.92	±	12.73^{a}	5.96	±	5.96	50.21	±	21.75^{a}
Mother's education																		
≤ 6th grade	20.80	±	1.05^{b}	16.47	±	7.52^{a}	69.32	±	11.11^{b}	31.79	±	6.82^{a}	0.85	±	0.60	126.81	±	13.55^{a}
6th - 9th grade	17.50	±	1.37^{b}	100.66	±	25.78^{b}	76.72	±	14.34^{b}	58.95	±	9.26^{b}	0.21	±	0.21	242.66	±	29.67^{b}
Completed high school	13.88	±	1.22^{ab}	227.33	±	32.84^{c}	49.11	±	11.68^{ab}	73.16	±	8.65^{b}	4.42	±	2.18	346.85	±	32.18^{c}
Some post secondary	16.93	±	3.70^{ab}	213.86	±	74.26^{bc}	39.46	±	26.38^{a}	95.69	±	28.57^{b}	4.24	±	3.41	360.59	±	62.85^{c}
Completed bachelor degree	13.00	±	3.37^{a}	344.51	±	65.87^{c}	7.18	±	7.18^{a}	50.88	±	13.74^{b}	4.04	±	4.04	370.62	±	68.54^{c}
Mother's occupation																		
Housewife (full time home)	17.99	±	0.80	109.18	±	14.93^{a}	65.85	±	8.08	49.75	±	5.11	2.60	±	1.03	228.85	±	15.88^{a}
Half time working	15.60	±	1.96	143.73	±	42.94^{a}	64.79	±	17.61	82.67	±	14.57	0.88	±	0.88	302.75	±	50.26^{a}
Full time working	11.98	±	1.88	309.09	±	63.74^{b}	26.45	±	10.53	88.17	±	16.90	2.21	±	2.21	419.66	±	56.44^{b}
Father's education																		
≤ 6th grade	18.35	±	1.24^{a}	26.94	±	14.33^{a}	66.25	±	11.84^{b}	38.49	±	9.53^{a}	0.52	±	0.52	145.77	±	25.47^{a}
6th - 9th grade	21.30	±	1.57^{b}	39.38	±	19.07^{a}	78.69	±	15.87^{b}	44.34	±	9.89^{a}	0.00	±	0.00	171.79	±	22.71^{a}
Completed high school	15.41	±	1.06^{a}	188.76	±	27.67^{c}	60.18	±	10.78^{b}	66.81	±	7.26^{b}	4.08	±	1.78	311.56	±	26.98^{b}
Some post secondary	18.35	±	1.32^{a}	114.07	±	23.37^{b}	69.44	±	13.33^{b}	55.58	±	8.57^{b}	2.04	±	0.89	241.67	±	24.84^{b}
Completed bachelor degree	16.96	±	2.38^{a}	205.99	±	51.29^{c}	6.78	±	4.72^{a}	88.76	±	21.12^{b}	3.52	±	2.52	304.31	±	47.39^{b}
Income/capita (USD/month)																		
< 25	21.60	±	1.02^{b}	15.68	±	14.94^{a}	85.08	±	18.90^{b}	26.28	±	7.66^{a}	0.85	±	0.85	136.94	±	23.30^{a}
25 – 49	18.05	±	1.20^{b}	71.74	±	15.62^{ab}	75.55	±	11.49^{b}	46.26	±	6.93^{a}	3.68	±	1.94	208.98	±	19.95^{b}
50 – 99	15.97	±	1.21^{ab}	133.02	±	24.02^{b}	52.60	±	11.76^{a}	72.23	±	9.06^{b}	1.11	±	0.68	257.29	±	24.93^{b}
100 – 249	13.05	±	1.74^{a}	387.10	±	50.81^{c}	23.98	±	10.23^{a}	67.98	±	12.39^{b}	0.55	±	0.41	453.03	±	52.11^{b}
≥ 250	16.29	±	3.23^{ab}	135.52	±	94.34^{b}	38.18	±	25.47^{a}	163.13	±	26.76^{c}	13.60	±	11.03	382.25	±	98.90^{b}

Note: USD: US Dollar (assumption 1 USD equal to 10 000 IDR); IDR: Indonesian Rupiah; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

4.3.2 Milk consumption

The focus of this part is to investigate the contribution of the milk intake on the phenomenon of double burden malnutrition. The investigation is divided into two periods, i.e. infancy and childhood.

Investigation during infancy

Exclusive- vs non exclusive- breast feeding

The grouping of the respondents according to whether they received exclusive breast feeding or not reveals that the exclusive breast feeding practice seems enable to protect the BMI of children from obesity range. Current result shows that children who received exclusive breast feeding have significantly (P-value < 0.05) lower BMI value (13.9) than the non received group (15.8) (**Table 4.13**).

Table 4.13 Mean value of BMI and BMI-for-Age z-score at 5 – 6 years old of children who received and do not received exclusive breast feeding

Nutritional status	N	BMI			BMIfAz		
		Mean	±	SE	Mean	±	SE
Non exclusive breast fed	235	15.77	±	0.25[b]	-0.10	±	0.12[b]
Exclusive breast fed	152	13.90	±	0.25[a]	-1.07	±	0.13[a]
Overall mean	387	15.05	±	0.19	-0.47	±	0.09

Note: N: number of respondents; IQ: Intelligence Quotient; EQ: Emotional Quotient; BMI: body mass index; calculated as kg/m2; BMIfAz: BMI-for-Age z-score; Mean: mean value; SE; Strandard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

It is true that the replacement of the breast milk by the infant formula during the infancy has correlation with childhood BMI. The result shows that the children group with the inclusion of formula fed have significantly (P-value < 0.05) higher BMI-for-Age z-score (-0.21 and 0.21) than the non formula group (-1.09) (**Table 4.14**).

Table 4.14 Mean value of BMI and BMI-for-Age z-score at 5 – 6 years old of children who received breast fed, breast and formula fed, and formula fed during their first six months

Infant group	N	BMI			BMIfAz		
		Mean	±	SE	Mean	±	SE
Breast fed infant	155	13.81	±	0.21[a]	-1.09	±	0.12[a]
Breast and formula fed infant	136	15.65	±	0.36[b]	-0.21	±	0.16[a]
Formula fed infant	96	16.31	±	0.41[b]	0.21	±	0.20[b]
Overall mean	387	15.05	±	0.19	-0.47	±	0.09

Note: N: number of respondents; BMIfAz: BMI-for-Age z-score; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

Child undernutrition

From the survey, the duration of breast feeding between undernourished children and normal children are not significantly different (**Table 4.17**). The frequency of the infant formula intake during 0 to 6 months of age between undernourished children and normal children is also not significantly different (**Table 4.15**). Formula milk powder is further investigated since this milk placed the majority portion among the commercial milks consumed by the beneficiaries. During the age of 7 months to 4 years old, the normal children consume significantly more frequent formula milk powder compared to the undernourished children (**Table 4.15**). And during age 5 to 6 years old, they consume more powdered milk (202.1 ml/day) compared to the undernourished children (SAM = 107; MAM = 128.9 ml/day; **Table 4.15**). No significant difference can be shown from other kind of milks during this period (**Table 4.15**).

From the aspect of food intake, a poor intake quality seems occurred beyond the infancy period. From the duration of breast feeding, during the infancy seems that the undernourished children received enough milk from their mothers. Cross tab of exclusive breast feeding and current nutritional status reflects this phenomenon (**Table 4.16**). The key answer seems coming from the quality of the complementary food during infancy, the current food behaviour, and the occurring disease which might influence the nutritional absorption of the body.

Child overnutrition

The overnourished children significantly receive breast feeding in shorter period (overweight = 12.7, obese = 12.3 months) than the normal children did (16.4 months; **Table 4.17**). From born until 5 years of age, they received formula milk powder more often compared to the normal children (**Table 4.15**). At age 5 years old, they received higher powdered milk (overweight = 367.6, obese = 381.4 ml/day) compared to the normal one (202.1 ml/day). They consume lower condensed milk during this age compare to other children. Normally they consume the condensed milk only as a complementary of their dessert.

Table 4.15 Consumption of formula milk powder (times/day) from 0 to 5 years old by nutritional status at 5 – 6 years old (BMI-for-Age z-score)

		0 - 6 m	7 - 12 m	1 - 2 y	2 - 3 y	3 - 4 y	4 - 5 y
Nutritional status	**N**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**
SAM	60	1.90 ± 0.65[a]	1.06 ± 0.33[a]	0.97 ± 0.26[a]	1.10 ± 0.23[a]	1.22 ± 0.25[a]	1.07 ± 0.24[a]
MAM	61	1.77 ± 0.37[a]	1.13 ± 0.23[a]	1.20 ± 0.19[a]	1.34 ± 0.21[a]	1.05 ± 0.21[a]	1.11 ± 0.23[a]
Normal	163	2.97 ± 0.41[a]	1.99 ± 0.21[b]	2.17 ± 0.19[b]	2.13 ± 0.17[b]	1.77 ± 0.16[b]	1.39 ± 0.15[a]
Overweight	43	5.47 ± 1.04[b]	2.86 ± 0.40[c]	3.54 ± 0.37[c]	3.74 ± 0.31[c]	3.34 ± 0.33[c]	3.02 ± 0.34[b]
Obesity	60	6.32 ± 1.12[b]	3.23 ± 0.40[c]	3.98 ± 0.36[c]	4.02 ± 0.33[c]	3.38 ± 0.30[c]	7.80 ± 5.29[b]
Overall mean	387	3.40 ± 0.30	2.00 ± 0.14	2.26 ± 0.13	2.32 ± 0.12	2.00 ± 0.11	2.41 ± 0.75

Note: N: number of respondents; m: month; y: year; BMIfAz: BMI-for-Age z-score; Mean: mean value; SE; Standard Error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

Table 4.16 Prevalence (%) of exclusive breast feeding (EBF) by the nutritional status

Nutritional status	**BMI-for-Age z-score**	**N**	**Non EBF**		**EBF**	
			N	**%**	**N**	**%**
SAM	< -3	60	28	46.67	32	53.33
MAM	-2 < z ≤ 3	61	29	47.54	32	52.46
Normal	-2 ≤ z ≤ 1	163	105	64.42	58	35.58
Overweight	1 < z ≤ 2	43	33	76.74	10	23.26
Obesity	> 2	60	45	75.00	15	25.00

Note: BMI: body mass index; calculated as kg/m2; N: number of respondents; SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition

Table 4.17 Duration of breast feeding (months) and usual daily milk intake at 5 – 6 years old (ml/day) by nutritional status (BMI-for-Age z-score)

	Breast milk*	**Milk powder**	**Reconstituted milk**	**Condensed milk**	**Heated milk**	**Total milk**
Nutritional status	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**
SAM	18.18 ± 1.49[b]	107.01 ± 22.02[a]	65.35 ± 9.12[ab]	59.09 ± 13.26[b]	4.41 ± 2.22	241.28 ± 25.27[a]
MAM	17.95 ± 1.02[b]	128.86 ± 26.88[a]	64.51 ± 9.56[a]	65.07 ± 13.03[b]	0.98 ± 0.51	265.50 ± 29.91[a]
Normal	16.39 ± 0.82[b]	202.14 ± 20.10[b]	85.06 ± 8.80[ab]	50.95 ± 8.08[b]	9.17 ± 4.23	345.54 ± 22.04[b]
Overweight	12.68 ± 1.59[a]	367.65 ± 56.10[c]	141.72 ± 31.96[b]	24.48 ± 15.00[a]	13.39 ± 5.55	549.04 ± 57.49[c]
Obesity	12.29 ± 1.37[a]	381.44 ± 40.35[c]	101.32 ± 14.83[b]	33.79 ± 15.88[a]	5.91 ± 2.6	512.50 ± 38.01[c]
Mean	15.86 ± 0.53	222.03 ± 14.24	87.58 ± 6.06	48.84 ± 5.38	7.1 ± 1.96	365.26 ± 15.04

Note: BMI: body mass index; calculated as kg/m2; N: number of respondents; BMIfz: BMI-for-Age z-score; SAM: Severe Acute Malnutrition (BMIfz < -3; N=60), MAM: Moderate Acute Malnutrition (-2 <BMIfz ≤ 3; N=61); Normal: -2 ≤ BMIfz ≤ 1, N=163; Overweight: 1 < z ≤ 2, N=43; Obesity: BMIfz > 2, N=60; Mean: usual daily intake of milk calculated by the MSM (Multiple Source Method); SE: standard error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

Investigation during childhood

Undernourished- vs normal- children

Usual daily milk intake of children during age 5 – 6 years old per group of BMI-for-Age-nutritional status is presented on **Table 4.17.** SAM- and MAM- children (undernourished children) consume significantly (p- value < 0.05) lower milk (241.3 and 265.5 ml/day) compared to those of the normal children (345.5 ml/day). Among four kind of consumed milk products (powdered-, reconstituted-, condensed-, and heated-milk), only the powdered milk which is consumed significantly different. SAM- and MAM- children consume significantly lower powdered milk (107 and 128.9 ml/day respectively) than the normal children do (202.1 ml/day).The duration of breast feeding among them is not significantly different.

Overnourished- vs normal- children

The usual milk intake among overnourished children is also interesting to be evaluated. In average, the overnourished children (overweight and obese) consume almost twice fold higher (549 and 512.5 ml/day) than those of the normal children (345.5 ml/day; **Table 4.17**). Reconstituted- and heated- milk are not consumed differently by the normal and overnourished children. While the powdered- and condensed- milk are consumed differently by them. The overnourished children consume significantly higher powdered milk (367.6 and 381.4 ml/day) compared to the normal children do (202.1 ml/day). Interestingly, the overnourished children consume significantly lower condensed milk (24.5 and 33.8 ml/day) compared to the normal children do (50.6 ml/day). The overnourished children had been breast fed for significantly shorter duration, i.e. 12.7 and 12.3 months for overweight and obese- children respectively, compared to the normal children received (16.4 months).

The assessment on the percent contribution of the milk intake on daily DRI gives better insight to investigate the contribution of the milk intake during childhood on the phenomenon of double burden malnutrition. This assessment is presented on the **Table 4.18** for macronutrient and **Table 4.19** for some micronutrients**.** As a note, only micronutrients mentioned on nutrisurvey, packaging, and list of food composition are presented here.

Table 4.18 Percent contribution (%) of the intake from average food recall on the DRI macronutrients of children age 4 to 6 years old

Nutritional status	BMI-for-Age z-score	N	Energy			Protein			Fat			Carbohydrate		
			Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
From all food intake without milk														
SAM	< -3	60	70.02	±	2.74a	112.16	±	5.35ab	97.62	±	5.30a	58.05	±	2.16a
MAM	-2 < z ≤ 3	61	65.77	±	2.07a	100.80	±	3.85a	88.01	±	3.48a	57.00	±	2.22a
Normal	-2 ≤ z ≤ 1	163	70.69	±	1.73a	114.73	±	3.13b	96.47	±	2.71a	59.36	±	1.71a
Overweight	1 < z ≤ 2	43	75.71	±	4.29a	128.58	±	7.52c	101.01	±	6.06a	63.39	±	4.23a
Obesity	> 2	60	76.96	±	3.67a*	146.13	±	7.10c	108.25	±	6.04a*	59.17	±	3.51a
Overall mean		387	71.28	±	1.18	118.18	±	2.26	97.44	±	1.89	59.26	±	1.13
From milk intake														
SAM	< -3	60	12.67	±	1.99a	19.54	±	3.08a	12.55	±	2.07a	13.54	±	2.12a
MAM	-2 < z ≤ 3	61	14.57	±	2.04a	20.00	±	3.28a	14.81	±	2.15a	15.73	±	2.17a
Normal	-2 ≤ z ≤ 1	163	20.25	±	1.71b	32.04	±	2.96b	20.18	±	1.78b	21.49	±	1.80b
Overweight	1 < z ≤ 2	43	20.92	±	3.12b	35.75	±	5.79b	20.78	±	3.55b	21.65	±	3.04b
Obesity	> 2	60	21.77	±	2.45b	36.53	±	3.99b	22.01	±	2.61b	22.58	±	2.61b
Overall mean		387	18.50	±	1.01	29.31	±	1.73	18.51	±	1.07	19.55	±	1.05
From total food intake														
SAM	< -3	60	82.70	±	3.31a	131.70	±	6.55a	110.16	±	5.70a	71.60	±	2.75a
MAM	-2 < z ≤ 3	61	80.34	±	3.05a	120.79	±	5.47a	102.83	±	4.09a	72.74	±	3.37a
Normal	-2 ≤ z ≤ 1	163	90.94	±	2.59b	146.77	±	4.82b	116.65	±	3.28b	80.85	±	2.63a
Overweight	1 < z ≤ 2	43	96.63	±	5.12bc	164.33	±	9.40bc	121.79	±	7.20b	85.05	±	4.81a
Obesity	> 2	60	98.72	±	4.41c	182.66	±	7.99c	130.26	±	6.73b*	81.74	±	4.29a
Overall mean		387	89.78	±	1.60	147.49	±	3.08	115.95	±	2.22	78.81	±	1.57

Note: BMI: body mass index; calculated as kg/m2; N: number of respondents; SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; Mean: usual daily intake of milk calculated by the MSM (Multiple Source Method); SE: standard error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

Table 4.19 Percent contribution (%) of the intake from average food recall on some DRI micronutrients of children age 4 to 6 years old

Nutritional status	Vitamin A			Ca			P			Fe			Zn		
	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
From all food intake without milk															
SAM	109.91	±	9.70a	18.34	±	1.77a	92.13	±	4.31a	71.99	±	4.58a	76.55	±	3.42a
MAM	111.67	±	8.53a	19.62	±	1.71a	83.73	±	3.66a	73.89	±	4.15a	69.62	±	3.08a
Normal	121.17	±	6.83a	21.14	±	1.21a	98.29	±	4.46b	76.88	±	2.89a	77.06	±	2.15a
Overweight	130.57	±	11.06a	21.49	±	2.22a	107.04	±	6.61bc	79.77	±	7.25a	85.17	±	5.71ab
Obesity	141.47	±	14.32a	21.32	±	2.26a	115.16	±	6.15c	83.88	±	5.49a	95.02	±	5.09b
Overall mean	122.00	±	4.28	20.55	±	0.76	98.43	±	2.44	77.03	±	1.96	79.28	±	1.58
From milk intake															
SAM	37.35	±	5.72a	39.07	±	6.97a	47.08	±	8.04a	30.87	±	8.96a	28.66	±	5.84a
MAM	39.27	±	5.36a	38.11	±	7.03a	46.81	±	8.19a	31.29	±	6.99a	30.49	±	6.47a
Normal	59.79	±	5.35b	56.09	±	5.18b	66.87	±	5.92b	45.75	±	6.02b	46.47	±	5.47b
Overweight	62.07	±	9.37b	62.63	±	12.49b	77.02	±	13.79b	62.07	±	13.82b	60.86	±	11.45bc
Obesity	64.63	±	7.36b	66.66	±	8.10b	77.01	±	8.80b	57.36	±	11.68b	66.47	±	9.88c
Overall mean	54.07	±	3.04	52.92	±	3.34	63.35	±	3.77	44.87	±	3.92	45.85	±	3.40
From total food intake															
SAM	147.25	±	10.54a	57.42	±	6.82a	139.21	±	8.74a	102.86	±	10.13a	105.20	±	6.74a
MAM	150.95	±	11.02a	57.73	±	7.19a	130.54	±	9.67a	105.18	±	8.23a	100.12	±	7.53a
Normal	180.96	±	8.95a	77.23	±	5.21b	165.16	±	7.56b	122.63	±	6.72b	123.52	±	6.20b
Overweight	192.64	±	14.17a	84.12	±	12.73b	184.06	±	16.34bc	141.84	±	15.39b	146.03	±	12.70c
Obesity	206.11	±	15.22a	87.99	±	8.68b	192.17	±	11.02c	141.23	±	12.02b	161.49	±	11.00c
Overall mean	176.07	±	5.34	73.48	±	3.40	161.78	±	4.69	121.90	±	4.36	125.14	±	3.91

Note: BMI: body mass index; calculated as kg/m2; N: number of respondents; SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition; Mean: usual daily intake of milk calculated by the MSM (Multiple Source Method); SE: standard error; Mean values with superscript letters (a-c) are significantly different (P-value<0.05) according to Mann-Whitney U test.

General look on the above percent contribution of milk on the DRI presents that milk has an important role, not only to cover DRI of energy, fat, and carbohydrate, but also the major needs of some micronutrients like Ca, Fe, and Zn. Without milk intake, only about 70% of DRI of energy is covered, and milk cover about the rest 20% needs of energy. Milk also gives an additional intake of about 20% DRI of fat and 20% DRI of carbohydrate. Observing the percent contribution on DRI micronutrients demonstrates that without milk, only about 70% DRI of Fe and Zn are covered, which then milk enable to cover the rest needs of these minerals. Moreover, from the intake of all food without milk, only about 20% of DRI Ca is covered. Milk contribute about 56% of daily Calcium need (**Table 4.19**).

Then what the linkage of the milk intake on double burden child malnutrition?

Undernutrition

When the milk is excluded from the intake, it could be shown that there is no significant difference on the daily DRI coverage between normal- and undernourished- children (**Table 4.18** and **4.19**). The food intake without milk only covers part of the daily requirements, i.e. about 70% energy, 60% carbohydrate, 20% Ca, 70% Fe, and 70% Zn. This indicates that the quality of the food intake without milk between normal- and undernourished- children is quite comparable. Then after the milk is included on the intake, there is any significant difference on the daily DRI coverage between normal- and undernourished- children. The DRI coverage of energy and some nutrients like protein, fat, Ca, P, Fe, and Zn on normal children is significantly higher than that of the undernourished children. A closer insight specific on the milk intake reveals that milk gives a notable portion on these significances, so that in overall food intake enable to cover the daily requirements. Current result demostrates that the presence of milk in the diet might protect the children from undernutrition by delivering significant amount of energy, protein, fat, carbohydrate, Vitamin A, Ca, P, Fe, and Zn (**Table 4.18** and **4.19**). The result from usual daily milk intake using MSM strengthens this finding, in which the normal children at age 5 – 6 years old consume significantly higher milk (345.5 ml/day) than that of the undernourished do (253.5 ml/d, **Table 4.17**).

Overnutrition

The percent coverage of food intake without milk on daily DRI of overnourished children tend to be higher for energy and fat, and significantly higher for protein, P, and Zn, compared to the normal children (**Table 4.18** and **4.19**). In general, the intake of macronutrients and some micronutrients are quite higher for overnourished children than the normal children do. But without milk, the total energy, carbohydrate, Ca, Fe, and Zn intake for overnourished children is still below 100% of DRI, i.e. 75, 60, 21, 80 and 90% respectively. The presence of milk in the diet enables to fulfil some of these lacks, i.e. 21% of energy, 21% of carbohydrate, 65% of Ca, 60% of Fe, and 65% of Zn. But then in the end, the overall intake (including the milk) result over intake which exceed the daily DRI, i.e. 175% of protein, 126.7% of fat, 200% of Vitamin A, 188% of P, 142% of Fe, and 155% of Zn. However, the current evaluation indicates that the percent contribution of milk on daily DRI is quite comparable between normal- and overnourished- children, except for Zn. But according to the calculation of usual daily milk intake using MSM presents that overnourished- children consumes significantly higher milk (527.75 ml/day) compared to the normal children (345.5 ml/day; **Table 4.17**). As a note, the previous milk intake of overnourished children (before the survey) is above this figure. The majority mothers of overnourished children confess that at the survey time they were programming their child diet by reducing the milk intake. From the above analysis, it is concluded that without milk, overnourished children consume over nutrients already, particularly protein and fat, but still lack of some micronutrients (Ca, Fe, and Zn). The over protein and fat intake from dishes and over milk intake is suspected as the source of overnutrition.

Which nutrition is the key factor of this double burden malnutrition?

Considering the aspect of nutritional intake on the phenomenon of double burden malnutrition during age 5 to 6 years old reveals interesting facts.

Child undernutrition

SAM children significantly (P-value < 0.05) consume lower energy (1029.30 kcal/day) compared to MAM children (1165.64 kcal/day; **Table 4.20**). This lower energy intake comes from the low intake of carbohydrate. SAM children significantly consume lower carbohydrate compared to MAM children, i.e. 130.6 and 148 g/day respectively. This very low carbohydrate intake becomes the key nutrition which make the moderate

undernourished phenomenon become more severe. And from this study, it is recognized that this lower carbohydrate is coming from food other than milk, where the food other than milk contribute to significantly lower carbohydrate in SAM children than in MAM children, i.e. 108.2 and 118 g/day respectively.

Then, comparing MAM children and normal children reveals that MAM children consume significantly lower energy than the normal children do, i.e. 1165.6 and 1334.4 kcal/day respectively. This lower energy is due to particularly the lower intake of protein (49.4 g/day; P-value < 0.01), fat (38.6 g/day; P-value < 0.05), but not carbohydrate (148 g/day; P-value > 0.05) in MAM children, compared to the normal children (protein = 48.94; fat = 56.85g/day; carbohydrate = 167.10 g/day; **Table 4.20**).

In the end, those facts discover that lower intakes of energy contribute on the undernourished phenomenon among respondents. Low energy due to the low protein and fat intake are experienced by the MAM children. And low energy due to the low protein, fat and carbohydrate intake is experienced by SAM children.

Plausible fact beyond those phenomenon is that the normal children received good quality and quantity of staple food (enough carbohydrate), dish (enough protein and fat), and milk (enough carbohydrate, protein and fat). MAM children receive good quality of staple food but poor dish and low milk. SAM children receive poor staple food, dish and milk.

Child overnutrition

Overweight children significantly receive more energy intake (1631.1 kcal/day) compared to the normal children (1334.4 kcal/day). Protein, fat and carbohydrate contribute to this. This is indicated from the significantly higher intake of these three nutrients (protein: 62.5; fat: 66.7; carbohydrate = 201.5 g/day) compared to the normal children received (protein: 48.9; fat: 56.8; carbohydrate = 167.1 g/day; **Table 4.20**). According to this value, protein and carbohydrate placed the particular portion on higher energy intake in overweight children.

Overweight consume significantly higher protein, fat and carbohydrate from milk; 17.9, 15.7 and 68.4 g/day respectively; compared to the normal children (protein = 9.1; fat = 8.8; carbohydrate = 38.9 g/day). Food other than milk contribute higher protein intake in overweight children (51 g/day) than in the normal children (48 g/day). Those significantly higher protein, fat and carbohydrate from milk (P-value < 0.01), and

significantly higher protein from food other than milk were suspected (P-value < 0.05) as the main contributor on the significantly higher energy intake of overweight children compared to the normal children.

According to the Mann-Whitney U test, none of above nutritional analysis from milk and food other than milk intake is significantly different between overweight- and obese-children, except the protein intake from food other than milk. From this study, it can be recognized that obese children consume higher protein intake from food other than milk (52.9 g/day) than the overweight children do (44.6 g/day). However, from this current survey, 20% of obese respondents (12 from total 60 obese children) confess that they are on the diet program. Most of them were entering the diet program by reducing the usual milk intake. Some mothers confess that they enable to reduce the milk intake of their children as many as one till two portion per day. This means that the total of milk intake in the past was probably higher than that from current presented result. The similar portion of staple food but higher portion of milk and dish are suspected as the key nutrient factors behind the linkage between child overnutrition and nutritional intake.

Subconclusion

In the end, according to the above evaluation and analysis, it can be concluded that milk as a part of children diet improves their nutritional status by covering daily macro- and micro nutrients requirement on preschool age in order to prevent the occurrence of undernutrition. But the intake should be controlled so that it protects the children from overnutrition. Bogor faces the phenomenon of double burden child malnutrition. Either under- or over- nutrition influence the children cognitive ability, particularly their memory ability. Exclusive breast feeding practice might has long term effect on enhancing the emotional quotient and protect the BMI of children on normal status. Infant feeding practices, breast milk vs formula milk has a strong correlation on the childhood overnutrition. Household income and maternal education have a strong correlation to the phenomenon of double burden malnutrition.

Table 4.20 Intake of energy, protein, carbohydrate, and fat from total food intake, milk only and, total food without milk by nutritional status (SAM, MAM, normal, overweight and obesity)

Nutritional status	BMI-for-Age z-score	N	Energy (kcal/day)	Protein (g/day)	Fat (g/day)	Carbohydrate (g/day)
			Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
			From total food intake			
SAM	< -3	60	1029.30 ± 28.84[a]	37.26 ± 1.74[a]	44.96 ± 1.82[a]	130.62 ± 8.67[a]
MAM	-2 < z ≤ 3	61	1165.64 ± 38.33[b]	38.57 ± 1.66[a]	48.82 ± 1.80[a]	147.98 ± 5.95[b]
Normal	-2 ≤ z ≤ 1	163	1334.40 ± 32.68[c]	48.94 ± 1.60[b]	56.85 ± 1.66[b]	167.10 ± 5.37[b]
Overweight	1 < z ≤ 2	43	1631.10 ± 64.79[d]	62.51 ± 3.44[c]	66.71 ± 3.64[c]	201.49 ± 8.24[c]
Obesity	> 2	60	1723.90 ± 70.54[d]	67.85 ± 2.96[c]	72.42 ± 3.46[c]	208.89 ± 11.39[c]
Overall mean		387	1367.30 ± 24.02	50.32 ± 1.15	57.71 ± 1.17	170.40 ± 3.63
			From milk intake			
SAM	< -3	60	153.45 ± 23.92[a]	5.13 ± 0.97[a]	4.96 ± 0.79[a]	22.38 ± 3.44[a]
MAM	-2 < z ≤ 3	61	193.51 ± 28.40[a]	5.97 ± 1.00[a]	5.89 ± 0.93[a]	29.96 ± 4.28[a]
Normal	-2 ≤ z ≤ 1	163	268.48 ± 18.51[b]	9.09 ± 0.72[b]	8.84 ± 0.64[b]	38.90 ± 2.66[b]
Overweight	1 < z ≤ 2	43	480.16 ± 53.46[c]	17.89 ± 2.06[c]	15.69 ± 1.90[c]	68.41 ± 7.42[c]
Obesity	> 2	60	446.49 ± 42.41[c]	15.49 ± 1.55[c]	14.29 ± 1.49[c]	65.16 ± 6.19[c]
Overall mean		387	296.24 ± 14.77	10.18 ± 0.56	9.59 ± 0.51	43.20 ± 2.12
			From all food intake without milk			
SAM	< -3	60	876.90 ± 29.64[a]	32.13 ± 1.57[a]	40.00 ± 1.89[a]	108.24 ± 8.64[a]
MAM	-2 < z ≤ 3	61	972.13 ± 30.51[a]	32.60 ± 1.29[a]	42.92 ± 1.70[a]	118.02 ± 4.90[b]
Normal	-2 ≤ z ≤ 1	163	1065.90 ± 24.93[b]	39.85 ± 1.37[b]	48.00 ± 1.52[b]	128.20 ± 4.28[b]
Overweight	1 < z ≤ 2	43	1150.90 ± 53.46[b]	44.63 ± 2.68[b]	51.02 ± 3.25[c]	133.08 ± 7.57[b]
Obesity	> 2	60	1287.50 ± 56.07[b]	52.88 ± 2.29[c]	58.48 ± 3.03[c]	144.99 ± 10.50[b]
Overall mean		387	1072.60 ± 17.66	40.26 ± 0.89	48.18 ± 1.01	127.37 ± 2.95

Note: BMI: body mass index; calculated as kg/m2, SAM: Severe Acute Malnutrition, MAM: Moderate Acute Malnutrition.

5 Discussion

The focus of the following discussion is to address these three main puzzles, i.e. (1) how is the current profile of the beneficiaries? (**sub chapter 5.1**: Current profile); (2) is there any correlation between the phenomenon of double burden child malnutrition and cognitive performance? And what is the plausible reason behind this correlation? (**sub chapter 5.2**: Double burden child malnutrition and cognitive development); and (3) how is the correlation between the phenomenon of double burden child malnutrition and some observed factors? And finally what is the possible solution to encounter this problem? (**sub chapter 5.3**: Affecting factors and possible solutions).

5.1 Current profile

From the current study, it was counted that more than half of beneficiaries suffer malnutrition. This is not only malnutrition in the term of undernutrition but also overnutrition.

There are abundant beneficiaries who suffer undernutrition. Using BMI-for-Age z-score from WHO reference 2007, prevalence of SAM is 27.1%, and MAM is 24.9%. The majority portion of undernourished children is originated from rural area (108 from 116 children; 93%).

The exact data of nutritional status using BMI-for-Age z-score from national research specific for preschool children age 5 to 6 years old is not available. Worldwide government is commonly more concern on under-five children compared to other age groups. But, on the other hand, this age 5 to 6 years range is a noticeable part for the next betterment of the nation, where they are on the stage of preparation entering school. In this transition area, children demand more energy and nutrients to support both their body and brain so that able to thrive. Moreover, according to WHO reference 2007, age 5 years old is the border where the group starts to use BMI as one of nutritional status indicator. Therefore, it is quite challenging to compare this current study result directly with the available national data.

The available data from national research was the nutritional status of preschool children age 5 to 12 years old. Using BMI-for-Age z-score, it was counted that as many as 4.0% of the children were severe acute malnutrition (SAM) and 7.2% of them were moderate acute malnutrition (MAM) or in total 11.2% of Indonesian young children age

5 to 12 years old were suffering of undernutrition (Riskesdas 2013: 258). Those figures and the current study results strongly indicate that part of Indonesian young generation are persistly suffering undernutrition due to lack of nutritional intake.

Couple years, Indonesia have made efforts to reduce undernutrition among its young generation. However, those results indicated that undernutrition persist a serious problem and remain unsolved.

With the undernutrition remains unsolved, it is emerging another kind of malnutrition among Indonesian young generation, that is overnutrition. From the current study, it is counted using BMI-for-Age z-score that 7.7% of beneficiaries suffered overnutrition, where 3.6% was overweight and 4.1% was obese. Observation on overnourished children among Indonesian was also reported by Riskesdas 2013. From children age 5 to 12 years old, using BMI-for-Age z-score, it was calculated that there was 10.8% children was overweight and 8% was obese (Riskesdas 2013: 258). This figure indicates a high prevalence of overnutrition among Indonesian young children, i.e. 18.8% (Riskesdas 2013: 258). It was also observed a high prevalence of overnutrition among Indonesian under-five children, i.e. 11.9% in 2013 (Riskesdas 2013: 42). The speedy emerging of child overnutrition is also being faced worldwide. It was projected that about 7.8% of under-five world children is overnutrition in 2015 (from UNICEF, 2012: 11 and de Onis et al., 2010: 1260).

Although the comparison of those national results and the current study result are quite challenging since the age category being evaluated was different, it is obvious that about a third of Indonesian young generation suffered from double burden malnutrition.

Double burden malnutrition is also observed from current research when using Weight-for-Age z-score as the indicator of the child nutritional status; as many as 16.7% of beneficiaries are underweight (2.9% severe and 13.8% moderate) and 5.2% of them are overweight. This figure is parallel with the report from Riskesdas (National basic research on health) which mentioned that in 2013 there were about 16.5% children who live in West Java were underweight (WfA z-score) (Riskesdas 2013: 44). Unfortunately no figure of overweight in West Java has been reported. But the national figure reported by Riskesdas 2013 (41ff) obviously indicated the phenomenon of double burden malnutrition among Indonesian children. It was reported that 19.6% of Indonesian under-five children was underweight (5.7% severe and 13.9% moderate), on the other hand 11.9% of them was overnutrition 11.9% (Riskesdas 2013: 42).

The national trend of undernutrition among Indonesian children was increased by 1.2% compared to the prevalence in 2007. Report from Riskesdas (2013: 251) mentioned that to reach the MDG, Indonesia should reduce the underweight children as many as 4.1% from 2013 till 2015 to reach 15.5% underweight children in 2015. While the national trend of overnutrition seems fluctuative but steady above 10% (Riskesdas 2013: 42). Those figures briefly presented the fact that Indonesia is facing double burden malnutrition among its young generation.

5.2 Double burden child malnutrition and cognitive development

Then what is the consequence of this double burden child malnutrition phenomenon into the betterment of the next generation? Current study evaluated the correlation of this phenomenon with the cognitive quality of the beneficiaries as the representative of the quality of Indonesian young generation. It was revealed that undernourished children had significantly lower memory ability compared to the normal children. The similar association was perceptible with the overnourished children who also had lower memory ability compared to the normal children.

5.2.1 Undernourished children and cognitive performance

A consistent finding on the correlation of child undernutrition and child cognitive development in Bogor – West Java was performed by Warsito et al. (2012). Warsito et al. (2012: 451) concluded that together with psychosocial stimulation (P-value< 0.001) and participation in early childhood education (P-value = 0.002), a good nutritional status based on height for age indicator (P-value = 0.028) had positive impact on the cognitive development of preschool children in Babakan village, Darmaga – Bogor, West Java, Indonesia.

The most current report on this correlation presented by Araujo et al. (2014: 1) which also found that the early exposure to poor social and nutritional environment might impair memory, learning, concentration, executive control and language on their adulthood. The poor social environment here was indicated by the low maternal education level. While the poor nutritional status was indicated by the low birth weight (Araujo et al. 2014: 8).

Plausible reason behind this evidence is that the poor nutritional quality during critical age (pregnancy, infancy, and childhood) might influence the brain development quality. Periods during pregnancy, infancy and childhood are the sensitive period in which the brain is massively grown. Insufficient nutrient intake and in-proper care during the first five years of life may influence the brain development which is not possible to be paid-off on the next period of life (Thompson and Nelson 2001: 8; Besty and Georgieff 2006: 158; Strain et al. 2008: 776; Wainwright 1992: 193). Since brain develops faster than the rest of the body, a dietary deficiency (due to hunger or undernutrition) during a critical stage of development may result in lasting changes in brain structure and function (Benton 2010: 457). Therefore, undernutrition especially for under-five children threatens the quality of the life, not only for their own life, but also the quality of the next generation as a cumulative society (WHO 2011; Dekaban and Sadowsky 1978: 355).

5.2.2 Overnourished children and cognitive performance

A sole systematic- and the most current- review on correlation of BMI and cognitive function was presented by Prickett et al. (2014: e1). The summary of the findings from this review provided evidence that obese adults indicated deficit cognitive performance in the following aspects: intellectual function, psychomotor performance and speed, visual construction, concept formation and set shifting, and decision making (Prickett et al. 2014: e17). The final conclusion from this comprehensive review presented that in overall there was insufficient evidence to reveal a robust linkage between obesity and cognitive impairment in adults (Prickett et al. 2014: e17). However from this comprehensive review an evidence for cognitive impairment in obese adults is indicated (Prickett et al. 2014: e19). Some plausible reasons on this evidence were: structural brain changes, impaired cerebral metabolism, elevated leptin, and inflammation (Prickett et al. 2014: e 17). Brain of obese adult was demonstrated to have greater brain atrophy, decreased grey matter volumes, increased white matter hyperintensities (Prickett et al. 2014: e17). Moreover, obese adults have a higher level of leptin, a hormone contained in body fat and has been identified might impair the cognitive ability (Prickett et al. 2014: e17). Inflammatory protein marker like c-reactive protein found higher in obese female and had negative influence on cognitive performance (Prickett et al. 2014: e17). This marker also identified might reduce the brain volume which might impair the brain neuron (Prickett et al. 2014: e17).

Yesavage et al. (2014: 150) found that the obesity-related disorders like diabetes,

hypertension and sleep apnea might be correlated with the poor executive function and auditory verbal memory, but the obesity itself had no direct correlation with these deficit cognitive performances.

Review from Willette et al. (2014: 1ff) drawn a conclusion that the increase of body fat was positively associated with the frontal grey matter atrophy in frontal lobe and prefrontal cortex on all age categories. This review also concluded that this evidence has a correlation with the parietal and temporal grey matter atrophy in middle and old age (Willette et al. 2014: 1). Atrophy is a phenomenon of volume reduction of brain tissue and cortical thickness due to the reduction of synaptic density, dendritic arborization, neurons, glia, and cell death (Willette et al. 2014: 1). This term also used to indicate the reduction of grey and white matter volume compared to the normal sample (Yaffe et al. 2004: 658; Willette et al. 2014: 2). These review explained that the majority finding research results found that the increase of BMI related to the reduction of grey matter volume and increase of white matter volume. A consistent finding was also found by Yokum et al. (2012: 656) and Brain Development Cooperative Group (2012). Willette et al. (2014: 8) resumed four potential mechanisms behind this evidence, i.e. (1) inflammation, (2) vascular risk factors, (3) insulin resistance, and (4) glucocorticoid and brain-derived neurotrophic factor.

Adiposity actively produces proinflammatory cytockines and chemokines via macrophage activation (Johnson et al. 2012: 900; Willette et al. 2014: 8). Higher pheripheral proinflammatory cytokine IL-6 was predicted due to atrophy on the grey matter volume and tissue density in temporal, frontal, and parietal regions (Willette et al. 2010: 2). Proinflammatory chemokine IL-8 was linked with the lower volume of bilateral hippocampus which was associated with memory ability (Dantzer 2004: 1). IL-8 could be a toxic wich might impair the nerve in hippocampus and hypothalamus area (Franciosi et al. 2005: 900; Liu et al. 2010: 1075).

Cardiovascular disease might impair the brain vasculatures which then contribute to deficit cognitive performance and the higher Alzheimer's disease (Yaffe 2007; Willette et al. 2014: 8). The strong reduction of cellular responsiveness to insulin which is noticed by higher insulin level in brain area which then influence the glucose level especially in periphery and brain area was predicted to reduce the overall cognitive performance (Willette et al. 2014: 8). Obesity might induce higher secretion of cortisol levels which then caused atrophy due to the decrease of brain-derived neurotrophic factor, the key modulator of synaptic activity in hippocampus and other areas (Willette

et al. 2014: 8).

It was concluded that obesity was not only evidently correlated to the high risk of cardiovascular disease, and various cancers, but also correlated to the cognitive impairment, dementia, and Alzheimer's disease (Willette et al. 2014: 9; Bauer et al. 2014: 1).

The consistent summary have been explored above, adult obesity has a negative correlation with the cognitive performance. Then, according to other literature, is this conclusion also applicable for child obesity?

Bauer et al. (2014: 1) examined the correlation between overweight/obese children and neuropsychological performance among Mexican children age 6 to 8 years old (N=18). This study found that the overweight/obese children had significantly lower (P-value =0.03) neuropsychological performance like verbal fluidity, learning ability, memory ability, and executive function. Corbett and Drewett (2004: 641) concluded that obesity lowers IQ till 4.2 points among children. The reduction of learning and memory ability is possibly be occurred because of the reduction of left hippocampal volumes (P-value =0.04). While, the lower executive functions might be due to the larger white matter volumes in the left cerebellum and mid-posterior corpus callosum (Bauer et al. 2014: 1ff).

A narrative review conducted by Burkhalter and Hillman (2011: 203S) confirms that finding, i.e. the inverse relationship between obesity and cognitive performance. The authors explained that overnutrition, in particular overnutrition of energy is maladaptive to brain health and function; obese children had a lower intelligence score as compared to the normal children. Further, such lower academic performance may persist when the obese children are getting mature into their teens. The reason on why obese children possess lower cognitive performance was considered due to changes in brain structure. Accordingly, BMI higher than 30 was associated with atrophy in the frontal lobes, the anterior cingulate gyrus, hippocampus, an thalamus relative to individuals with normal BMI (between 18.5 to 25). Obesity is associated with a decrease in brain volume which leads to lower attention, memory, control of cognition and scholastic performance (Burkhalter and Hillman, 2011: 203S).

A consistent finding on cognitive deficits in obese children has been concluded from a literature review by Smith et al. (2011: 741); eight of the nine studies displayed that obese children have significantly lower cognitive performance compared to the normal children. The low performance was shown from: executive function test, short-term

memory test, global function test, and verbal ability test (Smith et al. 2011: 741). A parallel finding also founded in adolescents, adults, and old adults (Smith et al. 2011: 741ff). The increase of adiposity was suspected as a plausible reason behind this evidence (Smith et al. 2011: 750). Systemic inflammation, triglycerides, and impaired insulin regulation was considered as the biological mechanism reason on the deficit cognitive performance on obese adult (Smith et al. 2011: 751). Biological mechanism behind this fact in young was not yet deeply investigated (Smith et al. 2011: 751). The volume of grey and white matter was the other plausible mechanism behind this evidence (Smith et al. 2011: 752). The increase of BMI was associated with the decrease grey matter volume in the orbito frontal cortex, the area where has an important role for executive function, and in right cerebellum, the area where has an important role for motor function (Smith et al. 2011: 752).

The above writing indicates a consistent finding that the obesity negatively correlated with the deficit of cognitive performance. Therefore, it could be stated that not only undernutrition which has a negative association with child cognitive function, but also overnutrition proved to have a negative association with child cognitive function.

Then, is this cognitive deficit among overnourished population is persistent or curable?

The review from Willette et al. (2014: 9) presented the correlation of calorie resistant, weight loss, and exercise with the recovery of cognitive impairment. Calorie restriction is an effort to restrict the calorie intake without losing the nutrient. Study from Colman et al. (2009: 201) found that the long-term calorie resistant might reduce central adiposity and help to preserve the grey and white matter volume so that repair the cognitive performance which did not different to the normal people (Sweet et al. 2012: 2220; Willette et al. 2014: 9). Moderate exercise led to increase the anterior hippocampal volume (Erickson et al. 2011: 3017) and repair the cognitive impairment (Chaddock et al. 2010: 172; Lautenschlager et al. 2008: 1027) into the normal level. Thus, the weight loss into the normal weight as the result of calorie resistant and exercise or active life has positive correlation with the cognitive impairment (Willette et al. 2014: 9). The above efforts were fit for adult and old people but not yet investigated for children. The further research on this area was demanded to tackle the current phenomenon, the emerging of childhood obesity.

However, either this cognitive impairment is persistent or curable, childhood obesity has become one of the most serious world health concern since the obese children

more likely to grow as obese adult which has consistent correlation with cognitive impairment and in the long term become more prone to premature death, disability, and some other noncommunicable diseases (WHO 2014). Another aspect of this puzzle is that the weight loss interventions in obese children is very costly and rarely successful (Von Kries et al. 1999: 1). Therefore the preventive action on childhood obesity is the best option to tackle this problem (Von Kries et al. 1999: 1).

5.3 Affecting factors and possible solutions

Related to this phenomenon, there were two main objects evaluated in this study, i.e. socioeconomic status as the external factor and milk consumption pattern as the internal factor.

5.3.1 Socioeconomic status

From the current study, it is calculated that about a third of beneficiaries (36.7%) received salary under minimum regional salary level. This figure is similar to the national figure. ILO (2013: 36) reported that the number of Indonesian who receive under minimum salary (about 200 USD) were 32.6% in 2013.

As a result of those facts, it is counted that as many as 14% of respondents lives under the poverty line. This figure is higher than was reported by BPS 2014. The prevalence of poverty in west java in 2013 was 9.6% (BPS 2014: 8), where 9.6% in Bogor Regency and 9.2% in Bogor City, which than if it takes the proportion of the population in Regency and City into account, in overall the prevalence of poverty in Bogor was 9.6% (BPS 2014: 8). Regardless to this different figure, it was presented the high number of the poor, not less than 9%. National figure of poverty also indicates a high prevalence of poverty. The poverty line in Indonesia in 2013 was Rp 291.951,-/capita/month or equal to 25 USD/capita/month (BPS 2014: 4). Number of Indonesians who live under the poverty line in September 2013 was 28.6 million people or 11.5% (BPS 2014: 1). The prevalence in urban was 8.5%, where as in rural area was 14.4%. The trend increased in comparison to the number of the poor on March 2013 which was 11.4%. There were additional poor as many as 28.1 million people within in one month (BPS 2014: 1). This increase is occurring in both urban and rural area of

Indonesia.

Surprisingly, BPS (2014: 1) mentioned that food was the major contributor (73.4%) to the poverty line which cigarette and instant noodle placed the second and the fourth most influenced ingredient to the poverty line, respectively. BPS (2014: 1) reported that the following food commodities were the most contributor items to the poverty line, i.e. rice, cigarette, egg, instant noodle, sugar, tempe, and shallot. This indicates that the majority Indonesian have less priority on nutritious food.

More than half of beneficiaries have low paternal education which most of their fathers and mothers were dropped out after finishing elementary school education. National situation has asimilar view. More than half (54%) of head of households in Indonesia only pursued elementary school in 2011 (BPS 2012: 22).

Then, how those economic and education facts contributes to the quality of the growth and the development of the Indonesian children?

Undernourished

Current study revealed that socioeconomic status has a linkage with the child nutritional status. Among the observed parameters on this study, capita income and mother education are the strongest determinants of the child nutritional status. Children with less capita income are more prone to be undernourished. Similar pattern with the maternal education, children with higher maternal education are less prone to be undernourished. Unclear pattern was observed among overnourished children. But from the current study, higher capita income and working mother contribute to the emerging of overnourished children.

Very small investigation has been published which spell out the correlation between socioeconomic status and child nutritional status in Bogor, West Java. Only two publications have been found which directly explain the impact of economic status on child nutrition in Bogor area, i.e. Widyatun (1991) and Matulessy et al. (1982). Widyatun (1991: 3) concluded that women's -education and -maturity has strong correlation with children's nutritional status, by improving women's education might improve the children nutritional status (Widyatun 1991: 3). Women's status defined by education, occupation and economic activity affect their decision making at home and their independence in society which then influence the food quality and care quality for their children (Widyatun 1991: 3). Widyatun (1991: 3) found correlation from her study

case in Bogor, West Java that the poorer status of women, the higher rate of child mortality. Matulessy et al. (1982: 401) also proved that environmental factors included socioeconomic status influence the nutritional status of under-five children in Bogor, West Java, Indonesia.

The most current research found that a hundred percent increase in real capita expenditure was associated with a 0.24 improvement in height index (Mani 2014: 82f). Mani (2014: 93) also studied the linkage between child nutritional status with mother's education, father's education, and expenditure per capita. She concluded that household income had the largest impact of child nutritional status (Mani 2014: 99). Household socioeconomic status had a strong impact on child health (Mani 2014: 99). Every additional one year of mother's schooling significantly increased child height index by 0.015 standard deviation (Mani 2014: 93). Father's education also had a positive impact but not significant (Mani 2014: 93).

Investigation about this issue among household in developing countries was presented by Babu et al. (2014; 322). It was concluded that economic status and women status have strong linkages in affecting child nutritional status among poor households. Many of observed household with nons working women were indeed poorer than the household with working mother. The poor condition tends to affect the children welfare in the term of lower food consumption and educational expenditures. This condition has long term effect on the undernourished status (Babu et al. 2014: 331).

Overnourished

The socioeconomic pattern among overnourished children is not clear in this study,due to the small prevalence among beneficiaries (7.7%). But, from the current study, it was obvious that the emerging of over-nutrition was largely coming from urban area (the prevalence was 3 fold higher), where they have higher income for more food, easier access to high calorie and fat food, more sedentary life, but less introduction on fruit and vegetable consumption (recognition from 24h food recall assessment). The number of working mother in urban was higher than that in rural area. The less time for preparing food among the working mother affected the food choice for fulfilling their children need. Often, ready to eat food become the final choice which most of these foods contain high calorie and fat but low nutrient. Low physical activity among children due to the limited space for playing and more option for sedentary games increased the probability of overnourishment among urban children.

Indonesia is a representative place where the under- and over-child nutrition becomes the burden problems (Roshita et al. 2013: 347). This country was also facing the rising of working mother which potentially influence the child care pattern (Roshita et al. 2013: 347). Roshita et al. (2013: 346) added that the irregular feeding practices due to the inappropriate care givers during the mother working hours might increase the risk of childhood obesity. Similar result from current study, that children from full time working mother more prone to overnuritrition. It is indicated that working mothers need to balance the trade-off between earning more income and the time constraint for child care practices and nutrient dense low calorie food preparation.

Tzioumis et al. (2014: 230) confirmed the above findings that economic status has a strong linkage on the emerging of child overnutrition.

Supporting the education of people is the basic step to reach the betterment of nation. Strengthening the education of people could produce a better quality of human resources which than enable to increase the capita income and capacity in taking care of their children. This increasing of capita income will strengthen the affordability of the parents to buy the food. The introduction of nutritional knowledge and child care knowledge among the parents will strengthen the ability of people in selecting the proper intake for their children. Then together with the enhancement of affordability in buying the food, this intake selecting ability will then enable to help the parents to provide a proper food in a proper amount and in a proper period for their children, the next generation. Then this proper intake accompanied with a proper child care will support the total child cognitive development. So that enables to deliver them to thrive.

However there were still other uncontrolled parameters which were not observed in this study, therefore, confirmatory studies focusing on childhood obesity are needed to clarify this relationship.

5.3.2 Milk consumption pattern

Examining the milk consumption pattern among the beneficiaries is becoming the next concern of this current study. It was not only due to the fact that milk places a noticeable portion throughout children life, but also milk places a top 25 of imported commodity in Indonesia.

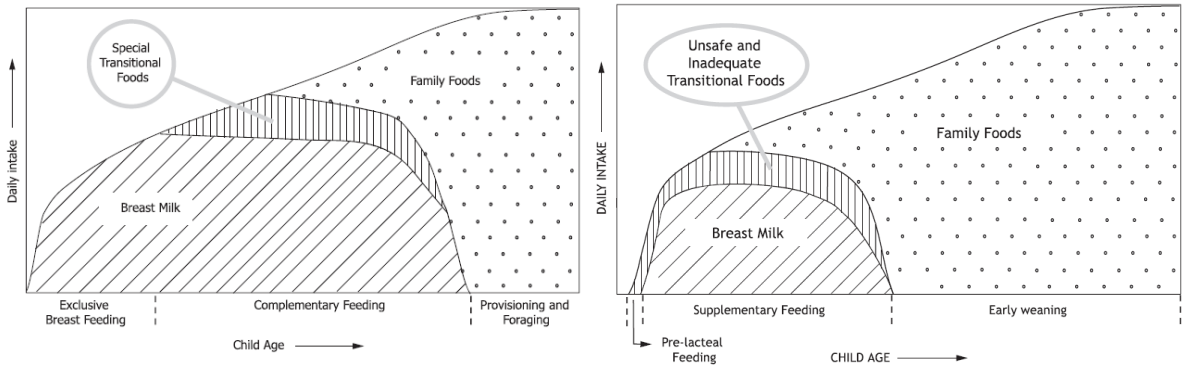
5.3.2.1 Infancy

No doubt that breast milk is the sole best food for infant 0 to 6 months of age. Thereafter, together with proper complementary food, the breast milk is still continued to be the best food for infant till two years of age or beyond. However, due to some urgent circumstances, many infants in the world are unable to be breast fed, so that they have to be fed with infant formula as the substitute. Many confession advised that the best infant feeding practice are initiation of breast feeding directly after birth, exclusive breast feeding from birth till 6 months of age, and continued breast feeding together with proper complementary food till age two years old (WHO 2003b: 7; Dewey 2001: 10). Early nutrition programming might define the long term health, well-being, and performance (Koletzko 2009: 17).

Despite the breast milk was knowledgeable as the sole best option for infant under 6 months, current study presented that less than half of mothers who confessed that they have practiced an exclusive breast feeding. It is counted that only about 45.3% of the beneficiaries who received exclusive breast feeding. Similar figure reported by KPPPA and BPS (2012: 105), only 43.4% of children age 2 to 4 who received exclusive breast feeding in West Java in 2011. Riskesdas (2013: 15) also reported the low rate of exclusive breast feeding. It was counted that only 30.2% of Indonesian infant age 6 months who received excusive breast feeding (Riskesdas 2013: 244). Prevalence of exclusive breast feeding among children age 0 to 2 years old was 38% (Riskesdas 2013: 187). And the rate of initiation of breast feeding within an hour of the delivery was only 35.7% in West Java and 34.5% in Indonesia (Riskesdas 2013: 243). Whilst the figure of formula-feeding was increasing every year (Riskesdas 2013: 244). Current study calculated that only a third of respondent (31.4%) who continued to be breast fed till two years of age. These low figures of breast-feeding practice indicated that the proper infant feeding is still rarely applied among the Indonesian society. Idris et al. (2013: 317) studied the driving force of Indonesian women to exclusively breast feed their children. It was found that the working mother was the main reason of the shorter

duration of breastfeeding. While maternal age, education, income and number of children has no association with the plan of exclusive breast feeding practice (Idris et al. 2013: 317).

Sellen (2007: 135) observed that the common shifting of infant and young children feeding practices were: discard the colostrum, use the prelacteal feeds, and reduce the breast milk intake due to early introduction of formula and other substances and start early weaning. A strong shifting might induce illnesses and death (Sellen 2007: 135).



(a) (b)

Figure 5.1 The shifting of infant and young feeding practices. Feeding phases optimal for healthy infant and young children (a) and commonly observed feeding practices not optimal for infant and young children (b).

Source: Sellen (2007, 131 and 135).

Moreover, due to the economic constraint and poor nutritional knowledge, it is observed from the current study that there are some infants among the beneficiaries were fed with other kind of food such as condensed milk, reconstituted milk and heated milk. This might harm the infant life and development. This inappropriate feeding practice indicates the poor nutritional knowledge among the mothers.

Infant feeding practice determines the infant growth pattern. Malpractice during this period might result a rapid weight gain which then might cause adverse health in later life (adulthood) (Koletzko 2009: 17). Beyond to ensure the healthy growth of children, current study reveals that exclusive breast feeding practice not only might protect the BMI of children on normal range in their childhood, but also strengthens their total emotional quotient.

Meta-analysis on breast feeding mentioned that breast feeding has less risk of adiposity and later obesity (Arenz et al. 2004: 1247, Weng 2012: 1019). This meta-

analysis suggested that the longer breastfeeding duration and later introduction of solids has a small correlation on later high BMI risk. Breast feeding is the one option to prevent the childhood obesity. Study in Bavaria interpreted that the breast feed for 3 to 5 months reduced the risk of childhood obesity till 35%. This fact might be an object to encourage mothers to prolong the duration of breast feed (Von Kries et al. 1999: 1). Von Kries et al. (1999: 9) concluded that Breast milk contains bioactive factors which modulate epidermal growth factor and tumour necrosis factor α, both of which are known to inhibit adipocyte differentiation in vitro.

Moreover, the amount of energy metabolized and the protein intake of breastfed children is considerably lower than formula fed children (Von Kries et al. 1999: 9). A longitudinal studies found that the higher dietary protein intake at the age of 10 months correlated to the higher of body mass index and the distribution of body fat in the later period (Von Kries et al. 1999: 9).

Theory of “Early Protein intake” mentioned that the high protein content in infant formula suspected as the contributor on childhood obesity which then increase the risk of NCD in the later life (Finucane 2011 557; Von Kries et al. 1999: 1). Related to this Early Protein hypothesis, Infant formula indicated to contain excess protein which might cause rapid increase of weight gain (Brands and Koletzko 2012: 1100). Koletzko (2009: 23) presented that infant formula contained higher amount of protein compared to breast milk which might induce the secretion of the growth hormone i.e. IGF-1 total and C-peptide/creatine. Contained protein in breast feed contributes 5% of the total energy intake while infant formula contributes 7% of the total energy. Protein was suspected to cause the increase of plasma tissue of insulinogenic amino acid so that enhanced the growth hormone (Alexy et al. 1999: 14). This increase of insulin and growth hormone was expected to stimulate fat deposition and the early development of adipocytes (Von Kries et al. 1999: 9).

Von Kries et al. (1999: 9) mentioned that in animal studies, the excess of protein during the fetal and post natal development correlated to the long term effect on glucose metabolism and body composition. Koletzko (2009: V) added that accelerated growth as a result of catch-up growth after fetal growth restriction or faster growth rate for formula fed infants might increase the obesity risk. Some studies mentioned that the growth and metabolism of baby from obese mother more susceptible to the weight gain in later life (Koletzko 2009: V). Early life has long-term consequences for health in

adulthood: obesity, cardiovascular, cancers, respiratory disease, cognitive decline. Therefore, there is a changing paradigm into the infant formula under concept of less energy and protein but high nutrient density formula (Koletzko 2014).

There are three efforts which need to be addressed to broaden the proper infant feeding practice. Those efforts are (1) enhance the appropriate and effective nutritional knowledge among the people, (2) facilitate the mothers to apply this practice, both for working- and nonworking mothers, and (3) promote the research studies on this area.

The promoting facilities should be started from breast-feeding initiation till the baby reach 6 months of age, such as: introduction and monitoring the breast feeding initiation practice in all delivery centres. To improve the practice of exclusive breast feeding, the international recommendation offers some solutions for employment mother, i.e. paid maternity leave, part-time work arrangements, on-site crèches, facilities for expressing and storing breast milk, and breastfeeding breaks (WHO and UNICEF 2003: 8). ILO Maternity Protection Convention, 2000 No. 183 and Maternity Protection Recommendation, 2000 No. 191 provide a regulation to protect the right of new born baby including that the institution should provide maternity leave period, day-care facilities and paid breastfeeding breaks (WHO and UNICEF 2003: 13).

International code of marketing of Infant formula

In the paid employment mothers' point of view, infant formula is much more efficient and easy to practice compared to provide the expressed breast milk. However in this case, breast milk feeding is the top choice and urgently to be supported by the environment. To prevent early cessation of breast milk feeding, in 1981, WHO endorsed an International Code of Marketing of Breast-milk substitutes (WHO 1981). According to the codes, the infant formula manufactures should not promote their products in hospitals, shops or to the general public; give free samples to mothers or free or subsidized supplies to hospitals or maternity wards; give gifts to health workers or mothers; promote their products to health workers: any information provided by companies must contain only scientific and factual matters; promote foods or drinks for babies; give misleading information; have direct contact with mothers (WHO 1981: 10ff,UNICEF 2013: 6ff).

This code is not legally binding. Therefore, although 30 years have been passed since endorsement, WHO (2013a) reported that only 19% of the member states have passed

the codes, and only 23% of them who functioning monitoring system. Collaboration, co-operation and communication are urgently required at all levels to ensure the success of the implementation of the Code.

5.3.2.2 Childhood

After the infant is fully weaned from breast milk and fully consume the family food, it is still recommended to include milk as a part of their diet. Milk is a favourable source of calcium due to its bioavailability in the body for supporting the healthy development of children, especially for their teeth and bones. The National Ministry of Health (NIH 2013; DH 2011; NHCS 2011) recommends the children beyond 2 years old to consume 550 ml low fat milk to fulfil daily intake 700 mg of calcium. Other calcium-rich foods like yoghurt and cheese could be possible as well to cover the daily need of calcium. Calcium is the largest mineral contained in the human body. Childhood is the period where the calcium requirement is very high when the bone formation exceeds the calcium resorption (The National Ministry of Health: NIH 2013; DH 2011; NHCS 2011).

Current study reveals that without milk intake, it is only about 20 to 70% of DRI is covered in either undernourished-, normal-, or overnourished- children. In all these children groups, milk helps to cover the DRI, especially the micronutrients Ca, Fe, and Zn. Milk does not only cover the micronutrient needs of undernourished- and normal-children but also the overnourished children.

It is demonstrated that milk helps normal children to cover the daily needs of nutrients by delivering significant amount of energy, protein, fat, carbohydrate, Vitamin A, Ca, P, Fe, and Zn, which might protect the children of being undernourished

From the current analysis, it is also summarized that over intake of protein and fat from dishes and milk were suspected as part of contributor of being overweight/obese. On the other hand it is presented that milk has a significant contribution in covering DRI of some micronutrients like Ca, Fe and Zn. Diet programming of nutrient dense food but less calorie seems become the solution for overnourished children, so that able to control the weight gain without being undermicronourished. Therefore, controlling the over consumption of calorie and fat from dishes seems more effective to control the weight gain in overnourished children, instead of only reducing the milk consumption. Means of the reduction of milk intake here is that till reach the recommended portion, 2 portions per day. The NNR evaluation demonstrated that milk is the superior nutrient

dense food for the children, which at the same energy level milk contain higher nutrients compared to other foods.

Abundant choices and types of milks are available for supporting the nutrition of Indonesian children. It is observed that almost all the consumed milk by the beneficiaries age 2 to 5 years was highly constructed and processed milk, instead of natural and fresh milk (less than 1%). Powdered milk, condensed milk, and reconstituted milk are very prominent among the beneficiaries. These milks are also recognized as growing up milk products.

The same result was shown by Roshita et al. (2013: 344); the formula milk takes a noticeable portion to the meal of Indonesian children. Not only in Indonesia, the growing up milk products place a considerable portion among Asian children diet (Brand-Miller et al. 2013: 29). Beside its availability, these growing up milks were prominent due to its convenience for storage. Mani (2014: 95) also mentioned that Indonesian household prefers condensed milk to cover their child nutrition than other kind of milk due to its convenience in storage without refrigerator. Not all Indonesian household owned a refrigerator (Mani 2014: 95).

It should be noticed that all these milk has extra added carbohydrates and other artificial micro nutrients. Brand-Miller (2013: 29) found that these milk products contain high level of added sugar which contributes to the higher postprandial glycemia which then might increase the risk of overweight/obesity and diabetes type 2. Baym et al. (2014: 1026) and Chepulis et al. (2009: 359) mentioned that intake of saturated fat and added sugar might lower the memory. The increase of fat diet might reduce the neurogenesis which then reduces the hippocampus volume (Grosso et al. 2014: 10; Rush University Medical Center 2013).

Brand-Miller et al. (2013: 23) examined that the addition carbohydrates (such as maltodextrins, corn or glucose syrups, sucrose, lactose, fructose) to the child milk powders increased the total glycemic index by more than two fold and glycemic load by seven fold compared to the non-carbohydrate added powdered milk. This study found that the added carbohydrate (excluding fibre) into the milk ranged from 0 to 21.5 g per serve. Diet with higher sugar and refined starch was correlated with later obesity and diabetes type 2 (Brand-Miller et al. 2013: 28). Total carbohydrate intake was correlated with higher glycemic index, increased BMI, and reduced visual ability (Brand-Millller et al. 2013). While the natural carbohydrate source for example from fruit, vegetables, low

fat dairy products generally have low glycemic index and might contribute to the lower BMI and waist circumference (Brand-Miller 2013: 28f).

However, deeper assessment on milk nutritional quality which balancing the real bioavailability of micronutrients and adverse impacts from some additional ingredients seems urgently required. Thus enable to present the proper milk choice, in a proper amount, at a proper time.

Demonstrating the appropriate food and introducing fruits and vegetables also could be one solution of the emerging of overnourished children in Indonesia. Indonesian young children age below 18 years old consume more frequent instant noodle (high calorie and nutrient sparse food) compared to the older group (Riskesdas 2013: 166). More than 90% of Indonesian consumed less fruits and vegetables in 2013 (Riskesdas 2013: 167). Only 10.7% of inhabitants consume fruits and vegetables daily (Riskesdas 2013: 171).

National food security is also become the next bottle neck of the national child nutritional security. Good nutritional knowledge and good income to afford the food, but lack of nutritious food choices then would never able to deliver the best food for the next generation. Good practice along the food chain from farm to fork, from cattle to table seems urgently monitored to provide the best food for children. “Best” in the term of quality, quantity, and safely delivered to the “table”. Safely means the nutrients quality without any harm effect in the safety point of view. Harm could be from food born diseases or artificial food additive.

As an illustration of national food security, number of cow and buffalo in Bogor was 63.4 million in 2013 (BPS 2014: 76). Number of dairy cows in Indonesia in 2013 was 444,221 cows, and it was reduced 28.58% from 2012 (621,962 cows) (BPS 2014: 76). While, in West Java, there were 103,832 cows in 2013, 30% lower than in 2012 (147,958 cows) (BPS 2014: 76). And number of Indonesian population in 2013 is 248.8 million people, which about a fifth of them are children age 0 to 9 years old (46.9 million) (BPS 2014: 12). Then how these 444 thousands dairy cows are able to deliver adequate milk intake to the 46.9 millions of Indonesian children? It becomes a big challenge, how 4.4 billion ml cow milk (10Littre of milk/cow/day x 444 thousands dairy cows), the daily milk supply from domestic production enables to cover the domestic daily milk demand as many as 239.5 billion ml of milk (500 ml milk/capita/day x 46.9 million children), which only enable to cover 1.8% of the national children need?

Therefore, milk is one of the major import commodities in Indonesia. This is the next “home work” that needs to be addressed.

6 Conclusions

6.1 Double burden malnutrition of preschool children and its association with milk consumption and brain development

Indonesia is facing a phenomenon of double burden malnutrition among the children. Child overnutrition is emerging while the prevalence of child undernutrition remains high and unsolved. From the current study, a small picture of child double burden malnutrition is shown in Bogor, West Java, Indonesia, where prevalence of SAM was 27.1%, MAM was 24.9%, and overnutrition (overweight and obesity) was 7.7%.

According to the current study, it could be stated that not only the child under-nutrition which has negative correlation with child cognitive performance but the child over-nutrition also proved to have a negative association with child cognitive function. It was shown from the low score of their memory ability. Lack of nutrient intake during the sprout growth period might impair the process of brain development in the hippocampus area. This becomes the plausible reason why child undernutrition has lower memory ability compared to the normal children. This impairment seems to be irreversible and could not be paid-off on the later life.

Increasing adiposity might induce inflammation and atrophy of grey matter in the hippocampus area which then influence the cognitive performance. This mechanism seems could answer why overnourished children has lower memory ability than the normal one. It is still questionable whether this mechanism persistent or curable. However, this correlation becomes a serious matter since the obese children are more likely to grow as obese adult who has consistent correlation with cognitive impairment and in the long term becomes more prone to many noncommunicable diseases.

Either undernutrition or overnutrition, the preventive action on this problem is preferable. Therefore the double burden child malnutrition should not be neglected to avoid ongoing quality loss of the next. Efforts are urgently needed to support early-life nutrition quality among them.

6.2 Future perspective

All actors have to aware, concern, and commit to reduce undernutrition while simultaneously prevent overnutrition. From the above analysis study, it could be drawn some alternative solutions to address the current phenomenon of double burden child malnutrition as a scientific pilot-suggestion in solving toddler's malnutrition in Indonesia, those are:

Breast feeding initiation and exclusive breast feeding practices becomes the prime concern for supporting the quality of the Indonesian children. These practices should continually be encouraged to support the optimal growth of the next. Promoting breast feeding practice by strengthening the knowledge and providing the facility for breast-feed mothers, especially among the working mothers so that able to protect the baby's right to get the best intake for their growth and development.

As the most nutrient dense food, a normal portion of milk (250 to 500 ml per day) plays as an important actor to help covering the nutrient needs of Indonesian children both macro- and micro- nutrients. It might help to prevent the child from being undernourished and reach the normal nutritional status. It also helps the normal and overnourished children in covering the nutrient needs particularly essential micro nutrients. Therefore promoting an adequate milk intake after the weaning period is preferable to support the child nutritional status.

Breaking the chain of poverty by socioeconomic improvement like strengthening the parental education and occupation might lead to improve nutritional knowledge and household affordability which in the end could increase the ability of households to choose the appropriate food for their children. In any kind of conditions, enhancing the nutritional education, especially for the mothers and child cares become a priority for the betterment of the next generation.

The last but not the least, strengthening the national food security system becomes the fundamental effort to support the healthy growth and development of the young.

These findings might also be applicable for other children in other areas in Indonesia and worldwide.

In the global context, the causes of under- and over-nutrition have to be opposed through integrated and systemic approaches for a better quality of the next generation of human beings.

However, this is an observational finding and uncontrolled confounding cannot be excluded as an explanation for the association. Therefore, confirmatory studies are needed to clarify these relationships.

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9 Curriculum vitae

Personal data

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Mailing address	:	Perum. Darmaga Hijau E3 Darmaga, Bogor 16680 West Java, Indonesia
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Educational background

2012 – 2014	Kassel University, Germany PhD candicate, Department of Organic Food Quality and Food Culture, Faculty of Organic Agricultural Sciences
2009 – 2011	Kassel University and Fulda University of Applied Science, Germany M.Sc. in study program of International Food Business and Consumer Studies
2001 – 2006	Bogor Agricultural University, Indonesia B.Sc. in Food Science and Human Nutrition, Faculty of Agricultural Technology

Working experiences

2011 – present	Lecturer at Department of Community Nutrition, Faculty of Human Ecology, Bogor Agricultural University, Indonesia
2011 – 2013	Meta-analyst and junior scientist, Department of Organic Food Quality and Food Culture, Kassel University, Germany (by distance)
2012	Lecturer at Diploma in Food Safety and Quality Management, Bogor Agricultural University, Indonesia
2010 - 2011	R&D staff, under project "Using biodiversity in product development for human well-being", Department of Organic Food Quality and Food Culture, Germany, Kassel University
2005 – 2009	Teacher for high school students at ILNA Learning Center Institute, Bogor; Gondanglegi High School, Malang
2002 – 2004	Lecturer assistant of Food Engineering Principles, Basic Chemistry I and II at Bogor Agricultural University, Indonesia

10 Publications 2012 - 2014

Peer-reviewed journals

Palupi E, Sulaeman A, Ploeger A. 2015. Double burden malnutrition and child cognitive performance: A study case in Bogor – West Java, Indonesia. (Manuscript preparation on Public Health and Nutrition)

Palupi E, Sulaeman A, Ploeger A. 2015. Milk consumption of preschool children age 5 to 6 in Bogor – Indonesia and its association with double burden malnutrition. (Manuscript preparation on International Journal of Food Science and Nutrition)

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11 Appendix

Appendix 1. Questionnaire for survey (English version)

UNIKASSEL
VERSITÄT
organicagriculturalsciences

PhD- Program in Department of Organic Food Quality and Food Culture
Faculty of Organic Agricultural Sciences

QUESTIONNAIRE

Dear respondent,

This questionnaire is intended for collecting the information regarding the pattern of consumption of children age 5 – 6 years who live in area Bogor, West Java, Indonesia.

I, Eny Palupi, the student who studying in PhD- Program in Department of Organic Food Quality and Food Culture, Faculty of Organic Agricultural Sciences, hereby state that the work contained in this questionnaire is aimed merely for finishing my study.

And surely that all the answers are anonymous. All of the content of information is going to use solely for finishing my dissertation with the title:

Malnutrition in Indonesia: Using Indonesian biodiversity
to explore nutrient dense foods for supporting
brain development of children age 0-5 years
Sub topic: Using a commercialized and non-commercialized variety of milk
to explore nutrient dense food for supporting brain development
of children age 0 – 5 years: A case study in Bogor, West Java, Indonesia

Therefore, it would be grateful in condition that Sir/Madam would not mind to give information regarding the consumption pattern of your children age 5 – 6 years.

Much appreciation is felt for Sir/Madam in answering this questionnaire. There is no better word to express my sincere thanks for your attention, time, help as well as information.

Sincerely yours,

Eny Palupi

Questionnaire

(As a note: one questionnaire only for one child)

Code: ..... (Filled by the enumerators)

A. Profile of family/household

1. Home address:

   .....

   .....

   a. Phone number: .....

   b. Number of inhabitant in one house: .....

2. Profile of parents

No.	Profile	Father	Mother
1.	Age		
2.	Education		
3.	Occupation		
4.	Income (rupiahs/month)[a)]		
5.	Typical of job [b)]		

Note: a) Income (rupiahs/month):

1: Less than 500.000,00

2: 500.000,00 – 1.000.000,00

3: 1.000.000,00 – 1.500.000,00

4: 1.500.000,00 – 2.000.000,00

5: 2.000.000,00 – 3.000.000,00

6: 3.000.000,00 – 5.000.000,00

7: More than 5.000.000,00

b) Typical of job:

1: Full time job

2: Part time job

3: Full time at home

3. Total income of one household (rupiahs/month): ..... (1 till 7)
4. Total expenditure (rupiahs/month): ..... (1 till 7)
5. Number of children: .....
6. Number of children age 0-5 years: .....

B. Profile of child

1. Name : .....
2. Age : ..... years and ..... months
3. Gender : ☐ male ☐ female
4. Weight : ..... kg
5. Height : ..... cm

C. History of childhood

1. The kid was born via (method):
   - ☐ Normal delivery
   - ☐ Caesarean section
2. How long the toddler has received an exclusive breast feeding?
   - ☐ Less than 6 months
   - ☐ 6 months
3. How long the toddler has received breast feeding?
   - ☐ Less than 6 months
   - ☐ 6 – 12 months
   - ☐ 12 – 18 months
   - ☐ 18 – 24 months
   - ☐ More than 24 months
4. Method of the breast feeding:
   - ☐ Direct breast feeding
   - ☐ Breast feeding via bottle, please specify the reason:

     .....
   - ☐ Both direct and indirect, please specify the reason:

     .....
5. Who is responsible for day to day caring the baby/toddler?
   - ☐ Mother
   - ☐ Grand mother
   - ☐ Other relatives please specify:
   - ☐ Baby sitter (pure)
   - ☐ Baby sitter doubles as housemaid
   - ☐ Day care
   - ☐ Others please specify:

D. Milk consumption

Age	Consumed milk			Frequency per-				One serving size (ml or medium glass)	Milk consumption[c)]
	Type[a)]	Taste[b)]	Brand[a)]	Day	Week	Month	Year		
0 – 6 months	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. …….								
6 – 12 months	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. …….								
1 – 2 years	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. …….								
2 – 3 years	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. ……. .								
3 – 4 years	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. ……. …….								

Age	Consumed milk			Frequency per-				One serving size (ml or medium glass)	Milk consumption[c)]
	Type[a)]	Taste [b)]	Brand [a)]	Day	Week	Month	Year		
5 – 6 years	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. . ……. . ……. . ……. .								
Current	Pure/fresh milk from farmer								
	Pasteurized/sterilized milk								
	Milk powder								
	Sweetened condensed milk								
	Soy milk								
	Others, please specify: ……. . ……. . ……. . ……. .								

a) What kind of “milk” that the toddler consumed normally? Varieties and brands (if available)

b) What is the taste of “milk” that the toddler consumed normally?

1: Plain

2: Sweetened by adding sugar by own

3: Sweetened from the factory

c) How much “milk” (milk or milk replacer) is normally consumed (in ml/day)? (note: a glass of milk is about 240 ml)

1: Never

2: Less than 150

3: 150 – 250

4: 251 – 500

5: More than 500

E. Other alternatives

In case the cow milk is unaffordable or not available, what kind of milk replacer that the toddler consumed normally?

.....

.....

.....

----- Thank you very much for taking the time to complete this questionnaire! ------

Code: ..... (Filled by the enumerators)

F. Food recall 2x24h

Please write down the type of food and the portion of each that have been consumed yesterday (Day 1) and will be consumed by the kid during next 24 h (Day 2)?

Day 1 (yesterday)

No.	Types of food	Amount/portion of-			
		Served	Cast-offs	Consumed	
		---------glass/plate/table spoon/teaspoon/etc.--------			----ml or g----

Code: ..... (Filled by the enumerators)

Day 2

No.	Types of food	Amount of/portion of-			
		Served	Cast-offs	Consumed	
		---------glass/plate/table spoon/tea spoon/etc--------			---ml or g---

----- Thank you very much for taking the time to complete this questionnaire! ------