CHILD STUNTING IN HOUSEHOLDS WITH DOUBLE BURDEN OF MALNUTRITION: APPLICATIONS OF BEHAVIORAL EPIDEMIOLOGY

by

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B.S., Universitas Airlangga, 2003
M.P.H., University of Queensland, 2007

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Human Nutrition
College of Human Ecology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2016

Abstract

Child stunting refers to a condition where the child is relatively shorter in height, in comparison to their age group. Child stunting is a public health nutrition problem that hinders the development of future generations, not only physiologically but also potentially deprives their cognitive function and productivity. The demographic transition, conjoined with the epidemiological and nutrition transitions, has resulted in the coexistence of an over- and under-nutrition problem known as double burden of malnutrition, and child stunting has been a persistent part of the problem. In 2014, the World Health Organization (WHO) reported that one-fourth of the children in the developing countries have been suffering from child stunting.

The objective of this research was to apply the behavioral epidemiology approach to tackle child stunting in households with double burden of malnutrition. It was hypothesized that unlike any other households with problem of child stunting, households with double burden of malnutrition possess some degree of capacity that, with proper support and direction, might enable them to help themselves reduce or prevent this nutrition-related debacle.

Results from a secondary data analysis revealed that child stunting was associated with lower dietary diversity as an indication of poor food choice in the household, related to children's nutrient requirements. Another cross-sectional study in this dissertation was conducted in an urban setting in Indonesia, and found that households with child stunting alone was associated with extreme food insecurity, while households with double burden of malnutrition ─ in the form of stunted child and overweight/obese mother (SCOWT) ─ was associated with even a mild degree of food insecurity. These results support our hypothesis that households with double burden of malnutrition lack the capacity to direct their resources properly to prevent child stunting. Most notably, we expected that the role of the mothers to manage healthy food choices

through indirect measure of dietary diversity, availability and distribution within the household was lacking. In order to equip mothers with necessary components to be able to overcome these problems, we conducted a behaviorally based intervention that targeted mothers in the households experiencing the problem of double burden of malnutrition. The intervention provided the potential to achieve participant self-administered goal setting to improve diet, as well as child feeding behavior, by means of improved self-efficacy, nutrition literacy and dietary diversity. Maternal self-efficacy may be potentially enhanced by vicarious experience and active mastery experience gained during 6 sessions of behavioral intervention and verbal motivation by community health workers during 6 additional home visits.

These studies, collectively comprising the present dissertation, present a message for policy makers in developing countries: nutrition literacy and behaviors for choosing healthy foods are lacking in mothers that affect both maternal and child food intake, but efforts such as improving vicarious and mastery experience on child feeding practices and healthy food choices can boost mother's self-efficacy to engage in appropriate behaviors and improve their child's nutrition.

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Approved by:

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Richard R. Rosenkranz

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Dedication

To my beloved wife Arianti and my three wonderful children — Muhammad Ismail Mahmudiono, Muhammad Ishaq Mahmudiono, and the USA-born Mazaya Ilmi Mahmudiono — for teaching me the art of patience and unconditional love.

To my late foster mom, Kasiyatin, for her lifetime of sacrifice and love. I pray to Allah SWT to bless you with *amal jariyah* in the form of this imperfect son of yours.

To all families experiencing the double burden of malnutrition around the developing world, especially in the urban city of Surabaya, Indonesia, with continuous effort and perseverance, together, we can solve this problem.

Chapter 1 - Introduction

Introduction

In the developing world, malnutrition persists as a major public health concern, attributable to nearly 35% of all deaths among under five years' old children (Black et al., 2013; Imdad & Bhutta, 2012). One type of childhood malnutrition is stunting, defined by the World Health Organization as a height-for-age z-score of less than -2 or equal to less than 5 percentiles (World Health Organization [WHO], 2006). In 2011, it was estimated that more than one-fourth of world's children were stunted (United Nations Children's Fund [UNICEF], World Health Organization [WHO], & the World Bank [WB], 2012). An article published the following year reported that there were approximately 178 million stunted children worldwide (Imdad & Bhutta, 2012). The prevalence of childhood stunting during the first 2 to 3 years of life was found to be increasing in many developing countries (Victora et al., 2010). The literature revealed that in cases where repeated bouts of infection with symptoms including diarrhea (Checkley et al., 2008) or when insufficient dietary intake caused linear growth to falter, catch-up growth could be achieved once infection was eliminated (Richard et al., 2014) or dietary needs were met (Kinyoki et al., 2016). In deprived environments where children were constantly exposed to inadequate dietary intake or a high rate of infection, catch-up growth was less likely, and growth was stunted as a result (Richard et al., 2012).

When stunted children were deficient in nutrients such as vitamin A, zinc, iodine and iron, they were unable to reach their full developmental potential (Black et al. 2013). A strong association exists between stunting early in life and impaired cognitive functioning (Casale, Desmond, & Richter, 2014). A study in Tanzania revealed that an improvement in the height-for-

age z-score (HAZ) among 18- to 36-month-old children was associated with better cognitive, communication, and motor development (Sudfeld et al., 2015).

The current shift in demographic, epidemiological and nutrition transition experienced predominantly by developing countries has led to a paradoxical phenomenon known as the double burden of malnutrition (Popkin, 2002). The double burden of malnutrition has been described as the coexistence of stunted child and overweight/obese mother (SCOWT) in a single household (Doak et al., 2005; Jehn & Brewis, 2009; Lee et al., 2010; Oddo et al., 2012). Child stunting is associated with poor cognitive performance. It results from a failure to eliminate infections or to improve proper diet, which largely has been attributed to a lack of household resources. We believe that in households facing the double burden of malnutrition, such resources may be available but are not directed properly to combat child stunting. A study in a Guatemalan population showed that households with SCOWT pairs have per capita consumption in the middle quintile, while households experiencing the stunted child (SC) problem were clumped in the lowest quintile (Lee et al., 2012).

Behavioral Epidemiology Frameworks of the Studies

To explore this hypothesis, this dissertation was conducted to answer a series of research questions suggested by the behavioral epidemiology framework (Sallis, Owen, & Fotheringham, 2000). Sallis, Owen, and Fotheringham defined behavioral epidemiology as a subset of research with the explicit objective of understanding and influencing healthful behavior patterns. This framework can be used as part of population-wide initiatives to prevent disease and promote health (Sallis et al., 2000). In this dissertation, I present six separate articles from three studies. Each addresses a specific research goal aimed at understanding or improving child nutritional

status. The main focus of these studies is on improving the mother's ability to make healthy food choices, and especially to improve child-feeding behaviors.

The first phase in the behavioral epidemiology framework is to establish the link between behavior and health (Sallis et al., 2000). In this case, the health issue is child stunting and its coexistence with maternal overweight/obesity, which results in the double burden of malnutrition. Taking this approach, the aim of the first article (Chapter 2) was to determine correlates of double burden of malnutrition as reported in peer-reviewed journals. After gathering published articles that describe some form of double burden of malnutrition, we analyzed the problem using the socio-ecological model (SEM). The SEM consists of several layers of levels that influence ones behaviors in a dynamic interaction. The levels ranging from individual, interpersonal, community, and policy level. I believe this model is best suited to capturing interrelations between levels and variables associated with the double burden of malnutrition. Though it was not possible to document a dose-response relationship between maternal behaviors and child stunting, an existing association was clearly depicted. In the first study (Chapter 3), I tested the link between healthy food choices and child stunting. I used secondary data from East Java, Indonesia, to understand the association between dietary diversity as an indicator of maternal healthy food choice and child stunting. This provides evidence that improving a household's dietary diversity could be initiated with an attempt in improving maternal capability to manage household's resources. Enabling the mother to make healthy food choices for entire family might be the key to eradicate child stunting.

The goal of the second phase of the behavioral epidemiology framework is to develop methods for measuring behavior (Sallis et al., 2000). In all three studies, we used validated behavioral measures, adapting behavioral instruments to the setting, and developing measures of

our own. To measure dietary diversity and food insecurity, we used an established method proposed and endorsed by the Food and Agriculture Organization of the United Nations (Food and Agriculture Organization of the United Nations [FAO], 2010; Food and Nutrition Technical Assistance Project [FANTA], 2007).

The third phase of behavioral epidemiology framework identifies factors that influence health behaviors. This was implemented by testing our hypothesis that in households exhibiting the double burden of malnutrition, the lack of dietary diversity as a measure of poor food choice was not affected by food insecurity and nutrition literacy. In the second study (Chapters 4 and 5) we looked at the correlation between food insecurity, dietary diversity and nutrition literacy, with the double burden of malnutrition measured as SCOWT. We hypothesized that in comparison to a food secure household, even a little food insecurity is associated with the double burden of malnutrition (SCOWT). We predicted severe household food insecurity to be significantly associated with child stunting.

I also undertook the fourth phase of the behavioral epidemiology framework, which is to evaluate an intervention to change the behavior. The third study (Chapter 6 and 7) analyzes the effect of a behavioral intervention aimed at improving maternal capacity for making healthy food choices for themselves as well as for their children. Using the constructs of Social Cognitive Theory (Bandura, 1989), I aimed to improve the child's height-for-age-score by improving maternal self-efficacy for healthy food choices and proper child feeding behaviors. Mothers were equipped with vicarious experience from experts and peers, mastered experience through cooking classes, and verbal motivation through motivational interviewing. We trained local community health workers to teach mothers how to overcome obstacles in making healthy food

choices for themselves and their children. The health workers visited mothers in their homes each for 30 minutes to answer questions and to encourage new behaviors.

It is my hope that this dissertation provides evidence that can be used to develop strategies for overcoming child stunting, especially in households facing the double burden of malnutrition. The fifth and final phase of the behavioral epidemiology framework can be initiated by local governments or policy makers by translating research results into practice to eradicate child stunting.

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Chapter 2 - Socio-Ecological Model of Correlates of Double Burden of Malnutrition in Developing Countries: A Literature Review

Abstract

Background: The double burden of malnutrition is a complex problem involving the coexistence of under- and over- nutrition within the same individual, household or population. This review aimed to discuss the correlates of double burden of malnutrition though the socio-ecological model (SEM). *Methods:* PubMed database was used to access peer-reviewed articles related to double burden of malnutrition. *Results:* The correlates of the double burden of malnutrition identified from previous literature were race/genetics, maternal short stature, breastfeeding status, low maternal education, family size, household food security, household dietary diversity, rural and urban settings. In the absence of evidence linking factors in certain level of the SEM and double burden of malnutrition, we employed correlates of overweight and obesity to complete this narrative. Potential intervention strategies were proposed in alignment with the targets and settings identified based on the socio-ecological approach. *Conclusions:* The double burden of malnutrition is a public health phenomenon associated with a variety of socio-ecological determinants. An integrated approach is needed to address the root causes of malnutrition in all its forms and at all life stages.

Keywords: double burden of malnutrition, nutrition transition, socio-ecological model

Introduction

One of the primary public health problems of the 21st century is the obesity epidemic that affects more than half a billion people worldwide (Bhurosy & Jeewon, 2014). The magnitude of the obesity problem is overwhelming in high income and developed countries. It is estimated that by 2008, 1.46 billion adults were overweight (body-mass index [BMI] >25 kg/m^2), and that 205 million men and 297 million women among them were obese (BMI >30 kg/m^2) (Finucane et al., 2011). Among developed countries, USA had the highest BMI (Swinburn et al., 2011). The trend in the prevalence of obesity among youth and adults in the U.S. between 2003 and 2004 and 2011 and 2012 remains high and did not change significantly (Ogden, Carroll, Kit, & Flegal, 2014) despite a substantive response by the Centers for Disease Control and Prevention (CDC) since 1999 (Dietz, 2015). Obesity does not only affect developed countries, developing parts of the world also suffer from it at a robust pace (Bhurosy & Jeewon, 2014). Data from the World Health Organization (WHO) from 1981 to 2008 showed that developing countries in Africa and Southeast Asia were relatively lower in overweight and obesity (Bhurosy & Jeewon, 2014), but it is expected that these countries will soon face the levels of overweight that are prevalent in developed countries such as the USA (Martorell, Khan, Hughes, & Grummer-Strawn, 2000). On the other hand, the prevalence of under-nutrition is far from insignificant. Even though the United Nation's efforts to combat malnutrition through Millennium Development Goals (MDGs) are progressing in the right direction (Bredenkamp, Buisman, & Van, 2014), almost half of all deaths among children under the age of 5 years are still attributable to undernutrition (Restrepo-Méndez, Barros, Black, & Victora, 2015). The United Nations Children's Fund (UNICEF) reported that in 2011 more than a quarter of world's children under 5 years of age were stunted and 16% were underweight (United Nations Children's Fund [UNICEF], World Health

Organization [WHO], & the World Bank, 2012). In developing nations, nutrient deficiencies manifested in under-nutrition (underweight, wasting and stunting) persist, while the problem of overweight and obesity increased rapidly. Reporting on studies in six developing countries, the Food and Agriculture Organization of the United Nations (FAO, 2006) referred to this phenomenon as double burden of malnutrition, where under- and over-nutrition occur simultaneously among different population groups in developing countries.

Existing studies define the double burden of malnutrition at the individual, household, and population or country level (Tzioumis & Adair, 2014). At the individual level, the problems of under- and over-nutrition coexist in the same individual. An example would be an individual who is obese and suffering from iron deficiency anemia at the same time (Gartner et al., 2014). One study in Mexico defined the double burden of malnutrition at the individual level as the concurrence of child stunting and overweight/obesity occurring with anemia in children and in women (Kroker-Lobos et al., 2014). At the household level, the problem occurs when one member is undernourished while another is overweight. Some studies have highlighted the phenomena of a stunted child and overweight or obese mother in the same household. Unfortunately, there is a lack of agreement on terminology. Several names have been used to represent this phenomenon including SCOWT (stunted child and overweight mother pairs) (Dieffenbach & Stein, 2012), SCOM (stunted child and overweight/obese mother) (Lee et al., 2012), DBM (double burden of malnutrition) (Ramirez-Zea, Kroker-Lobos, Close-Fernandez, & Kanter, 2014) and MCDB (maternal child double burden) (Oddo et al., 2012). Most studies in the peer reviewed literature describe the double burden of malnutrition at the population or country level where a portion of the population suffers from undernutrition while another part of the population faces the problem of over nutrition. At the national level, the double burden of

malnutrition has been identified in developing countries such as in South Africa (World Health Organization, 2011), Brazil (Doak, Adair, Bentley, Monteiro, & Popkin, 2005), China (Wang, Du, Zhai, & Popkin, 2007), Vietnam (Doak et al., 2005), and Bangladesh and Indonesia (Oddo et al., 2012) At the population level, the double burden of malnutrition was documented among adolescent girls in seven African countries (Manyanga, El-Sayed, Doku, & Randall, 2014). One study looked at Egyptian infants dealing with the double burden of malnutrition in the form of micronutrient deficiencies, stunting and overweight (Kavle et al., 2015). In Southeast Asian countries children are experiencing the double burden of malnutrition where prevalence of stunting and underweight is still high but prevalence of overweight and obesity is increasing at the same time (Le Nguyen et al., 2013; Rojroongwasinkul et al., 2013; Sandjaja et al., 2013).

Most developing countries undergoing nutrition transition suffer from the double burden of malnutrition at varying rates. A recent study revealed that double burden of malnutrition (DBMN) as measured in child underweight and adults overweight had already affected almost all 100 developing countries used in the analysis (Abdullah, 2015). A review of 28 studies (Abdullah, 2015) revealed that the problem exists all over the world, from the Asia Pacific region to Latin America and Africa. In a Mexican population study, the prevalence of double burden of malnutrition was 6.2% when measured as coexistence of maternal central adiposity and child stunting (MCA) (Barquera et al., 2007) and 8.4% when measured as SCOWT (Kroker-Lobos, et al., 2014). Prevalence in terms of SCOWT was higher in other Latin American countries such as Argentina with 12% (Bassete, Romaguera, Giménez, Lobo, & Samman, 2014), Ecuador with 13.1% (Freire, Silva-Jaramillo, Ramírez-Luzuriaga, Belmont, & Waters, 2014) and Colombia with 13.2% (Sarmiento et al., 2014). The prevalence of double burden of malnutrition was relatively low in several developing countries in Latin America such as Brazil (Conde &

Monteiro, 2014) and Chile (Atalah, Amigo, & Bustos, 2014). In Asia, a rural population study documented the prevalence of maternal child double burden (MCBD) as 11% in Indonesia and 4% in Bangladesh (Oddo et al., 2012). In Malaysia, the prevalence of the double burden of malnutrition measured as underweight child and overweight mother pairs was 29.6% in the general population (Ihab et al., 2013) and 12.5% among indigenous people of Peninsular Malaysia (Wong et al., 2015). When measured as SCOWT, the prevalence of double burden of malnutrition in the indigenous Malaysian population was 19.4% (Wong et al., 2015). These numbers clearly show that the double burden of malnutrition is an emerging problem in developing countries.

The increasing prevalence of double burden of malnutrition across studies in the same country highlights the emergence of this problem. Data from the Indonesia Nutrition Surveillance System showed the prevalence of the double burden of malnutrition in rural Indonesia was 11% in 2000-2003 (Oddo et al., 2012). In 2013, a study using 15-year panel data from 1993 to 2007 showed that the prevalence of double burden of malnutrition in Indonesia was 16% (Roemling & Qaim, 2013). A study involving 12,048 households in Indonesia estimated the prevalence of the double burden of malnutrition at 19% (Vaezghasemi et al., 2014). The most recent study in rural Indonesia documented the prevalence of double burden of malnutrition at a staggering 30.6%. This figure was understandably higher because the cut-off for maternal overweight used in the study was low at BMI>23.5 (Sekiyama et al., 2015). In 2005 a Guatemalan study revealed the prevalence of child and mother pairs made up of stunted children and overweight mothers was 16% (Kroker-Lobos et al., 2014) This number was slightly higher in a 2012 study where the SCOWT prevalence was 16.8% (Lee, Houser, Must, de Fulladolsa, &

Bermudez, 2012). A 2014 publication reported 20.0% of Guatemalan households as suffering from SCOM (Ramirez-Zea et al., 2014).

Two previous literature reviews have focused on the double burden of malnutrition. The first emphasized differences in the levels (Tzioumis & Adair, 2014). The second provided an update and additional analysis of double burden of malnutrition as measured by underweight child and overweight/obese adult pairs using the WHO countries dataset (Abdullah, 2015). Our literature review offers new insight into correlates of the double burden of malnutrition through the use of the socio-ecological model. This is a good starting point because it identifies significant correlates and characteristics of the target population most in need of intervention. With its multiple levels and interrelationships, we believe the socio-ecological model was best for capturing the complexity of double burden of malnutrition hampering populations in the developing countries.

Methods

In this literature review, we did not limit ourselves to specific levels and measures of the double burden of malnutrition, but placed equal emphasis on correlational evidence of this phenomenon. Relevant studies were identified using the PubMed database. Initial keywords searched were "double burden of malnutrition," "dual burden of malnutrition," "stunted child or overweight mother," and acronyms related to double burden of malnutrition such as DBM, SCOWT, or SCOM. We did not impose date restrictions, but limited our search to articles published in English. Reference lists from identified articles were examined for additional relevant studies missed by electronic database indexing. Articles were excluded if research was not conducted in developing countries. As of 19 January 2016, the above-mentioned keywords

turned up 1,806 articles; however, only 15 of those articles contained correlates of the double burden of malnutrition identified in this review. In the absence of correlates on specific levels of the SEM that are associated with double burden of malnutrition, we used correlates of overweight and obesity to complete the narrative.

Socio-Ecological Model of Double Burden of Malnutrition

Due to the complexity of the problem, we strived to describe and frame it in a logical, comprehensible manner that would enable policy makers to take necessary action. One approach widely used to describe complex phenomenon socio-ecological model (SEM). The socio-ecological approach to public health originated from the concept of the ecology of human development introduced by Bronfenbrenner in the 1970s (Brofenbrenner, 1977). He argued that along with human growth and environmental changes, multiple systems of interaction occur that are not limited to a single setting but further involve environments beyond the immediate situation (Brofenbrenner, 1977). Given that most public health challenges are complex, the SEM has been widely embraced in the field of public health (Richard, Potvin, Kishchuk, Prlic, & Green, 1996; Stokols, 1996). The SEM offers a more holistic approach that acknowledges interrelations among multiple levels of influence that impact health outcomes (Robinson, 2008). Levels described in the SEM are individual, interpersonal, community, organizational, and policy level.

Several studies have used Bronfenbrenner's ecological model and its development to understand complex health problems, such as sexual transmitted disease (Voisin, DiClemente, Salazar, Crosby, & Yarber, 2006), mental health (Atilola, 2014) and prevention of childhood obesity (Kellou, Sandalinas, Copin, & Simon, 2014). Similarly, we analyzed correlates of the

double burden of malnutrition in the context of the socio-ecological model initiated by Bronfenbrenner and later widely adapted for health promotion interventions (National Cancer Institute, 2005). Figure 1 illustrates the socio-ecological model pertaining to the double burden of malnutrition in developing countries.

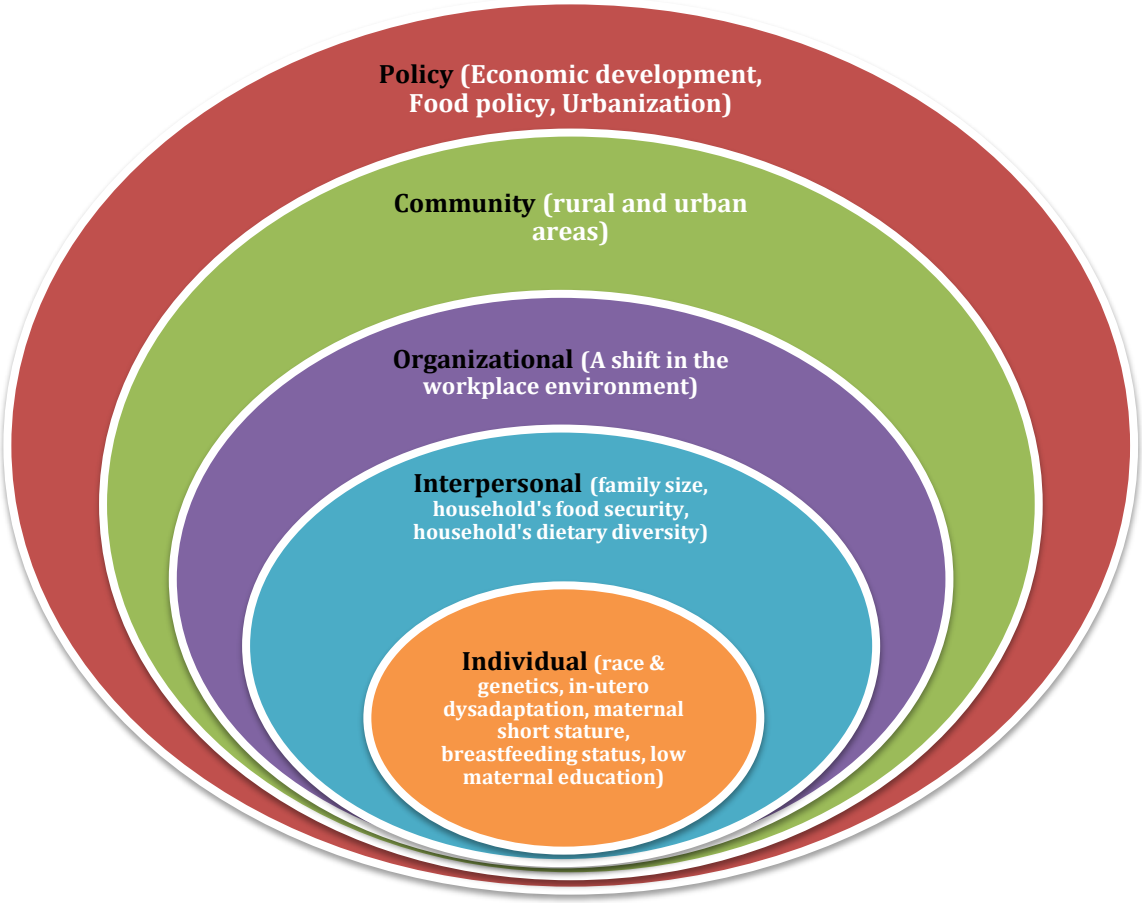

Figure 2.1 Socio-ecological model of correlates of double burden of malnutrition

The individual level is at the model's core, and forms a layer of personal attributes related to the double burden of malnutrition. Individual-level correlates are race and genetics, in-utero dysadaptation, maternal short stature, breastfeeding status, and low maternal education. The second interpersonal level represents direct influences or interactions between individuals. Related to double burden of malnutrition interpersonal correlates are family size, household food

security and dietary diversity. At the organizational level, the workplace environment is a potential correlate of the double burden of malnutrition. At the community level, correlates of the double burden of malnutrition are rural and urban areas. All of these levels are bound to policies and systems in place. For example, government and political structure, social structure, public policy, health care and food systems, economy and media are all a part of larger policies and systems that influence individual behavior. Policies and systems associated with the double burden of malnutrition are economic development, food policy, and urbanization. The SEM's underlying premises arguably are suitable for examining the phenomenon of double burden of malnutrition and interrelations among correlates, or determinants, on multiple levels. Hence, this review aims to summarize present knowledge about correlates of the double burden of malnutrition based on the socio-ecological model (SEM).

Individual Level

Race and genetics

Evidence shows that racial differences are associated with different rates of the double burden of malnutrition. Studies among Latin Americans revealed that being indigenous was associated with higher risk. The prevalence of coexistence of maternal central adiposity and child stunting (MCA) in a Mexican population was higher among indigenous families (Barquera et al., 2007). A study in Guatemala showed that being indigenous doubled the risk of SCOWT (OR=2.0, 95%CI=1.3-3.1) (Lee, Houser, Must, de Fulladolsa, & Bermudez, 2010). This study was supported by another study from Guatemala that highlighted higher prevalence in SCOWT pairs in indigenous households (28.2%) than non-indigenous households (14.4%) (Ramirez-Zea et al., 2014). The observed differences might be attributable to variations in body fat storage

between indigenous or non-indigenous populations, race or ethnicity. Because of important body composition differences that can lead to shifts in BMI-disease patterns, the WHO recommended reducing the BMI cut-off for overweight and obesity in Asian population (WHO Expert Consultation, 2004). Evidence shows that compared to Western populations, Asians had higher cardiovascular risk factors at any BMI level (Low, Chin, Ma, Heng, & Deurenberg-Yap, 2009).

In-utero dysadaptation (Barker hypothesis)

Maternal health status and lifestyle, including both under- and over-nutrition arguably play a key role in programming metabolic risk in the offspring. In the late 1980s, Barker postulated that maternal nutritional condition during pregnancy can "program" the fetus for the development of chronic disease later in life (Rasmussen, 2001). The fetal origins or Barker hypothesis stated that under nutrition and unfavorable intrauterine environment at critical periods in early life can cause permanent changes (in both structure and function) in developing systems of the fetus (Barker, 2012). These system changes may manifest as disease over a period of time due to "dysadaptation" with changed environmental circumstances (Barker, 2012).

The double burden of malnutrition may provide support for the Barker hypothesis. Embryonic and fetal growth starts with proliferation, organization, and differentiation of the embryo, followed by continued growth and functional maturation of the different fetal organs and tissues (Ornoy, 2011). This process depends on the genetic profile of the embryo, the maternal-placental-fetal unit, adequate nutrients and oxygen supply to the developing fetus, maternal prenatal weight, and maternal weight gain during pregnancy (Ornoy, 2011). When the undernourished, Barker postulates that the fetus will adapt to this adverse in-utero condition by using limited nutrients more efficiently (Rasmussen, 2001). Even so, the outcome of the

pregnancy will likely to be malnourished child. Later in life, changes in external conditions, such as influx of energy dense food readily available for the formerly stunted infant, catch-up growth takes the form of body weight, rather than height. Hence, in a Latin America population adults were getting shorter but BMI increased, resulting in overweight and obesity (Rivera et al., 2014). This evidence provides evidence for the hypothesis that adult disease originates through fetal growth and results in permanent changes in endocrine and metabolic process (Holt, 2002).

Breastfeeding status

Breastfeeding behavior has been found to protect against the double burden of malnutrition. In Indonesia, for a child who was breastfed, the odds of having MCDB was 0.84 times compared to a child was not breastfed (95%CI=0.81-084) (Oddo et al., 2012). The protective effect of breastfeeding was even greater in a Bangladeshi population, where the odds ratio (OR) of having MCDB was only 0.55 (95%CI=0.52-0.58) (Oddo et al., 2012). During the first four to six months of age a baby that is breastfed exclusively grows faster (Chomtho, 2014). Compared to formula-feeding infants, the breastfeeding of infants also protects against childhood obesity by providing a higher level of leptin, which results in better control of the satiety signal, food intake and adiposity (Chomtho, 2014). Breastfeeding for a minimum period of 30 days had a protective effect against overweight in preschool children of the semiarid region of Alagoas, Brazil (Ferreira et al., 2009).

Maternal short stature

Ample evidence shows that short maternal stature is associated with child stunting, but evidence associating it with double burden of malnutrition was limited. A study in Brazil revealed that children with a mother whose height is less than 145cm had lower height-for-age z-score (HAZ) than children whose mother was more than 160cm tall (P<0.0001) (Felisbino-

Mendes, Villamor, & Velasquez-Melendez, 2014). A study in Uruguay showed that maternal short stature of <160cm was a significant predictor for child stunting (Bove, Miranda, Campoy, Uauy, & Napol, 2012). This result aligns with a previous study in Brazil that highlighted the association between short maternal stature with low birth weight (<3000gr; *P*=0.01) and stunting (*P*=0.019) (Ferreira et al., 2009). In another population, Mexican children with a mother below 150cm tall were 3.6 times more likely to be stunted than children with a mother who is taller than 150cm (Varela-Silva, Azcorra, Dickinson, Bogin, & Frisancho, 2009). Even though the author mentioned that the studied settings had undergone double burden of malnutrition, the association of maternal short stature was only analyzed in relation to child stunting and not maternal nutritional status, and hence, the association with double burden of malnutrition in the previously mentioned studies (Felisbino-Mendes, et al., 2014; Bove, et al., 2012; Ferreira et al., 2009; Varela-Silva, et al., 2009) was hypothetical. A study using large sample in rural Indonesia and Bangladesh revealed the association between maternal short stature and maternal child double burden (MCBD) (Oddo et al., 2012). The Indonesian data showed households that have mother short in stature increase the OR for MCBD 2.32 times (95%CI=2.25-2.40) similar to data collected in a Bangladeshi population with OR=2.11 (95%CI=1.96-2.26) (Oddo et al., 2012). This evidence aligned with the results from a study in Guatemala that revealed maternal short stature as a risk factor for SCOWT (aOR=3.1, 95%CI=2.1-4.7) (Lee et al., 2010).

Low maternal education

Similar to other correlates of double burden of malnutrition on the interpersonal level, maternal education was extensively studied as a predictor of child stunting, but was rarely studied as a predictor of double burden of malnutrition. Low maternal education has been linked with child stunting (Bove et al., 2012). Twelve months maternal education intervention towards

specific task on improving child's intake such as complementary and responsive feeding education significantly reduced child stunting (OR=0.19, 95%CI=0.0-0.04) among rural Indian toddlers (Vazir et al., 2013). A quasi-experimental community-based trial providing mothers with biweekly group activity accompanied by monthly home visits significantly reduced the risk of child overweight (BMI-for age >85th percentile) but did not significantly reduce child stunting (Navarro, Sigulem, Ferraro, Polanco, & Barros, 2013). Related to double burden of malnutrition, analysis of the Demographic Health Survey (DHS) dataset from 18 lower and middle-income countries showed that low level of maternal education increased the likelihood of SCOWT (Jehn & Brewis, 2009). A study among an indigenous population in Malaysia showed contradictory results, in which having mothers with high education increased the likelihood of SCOWT (aOR=1.7, P <0.05) (Wong et al., 2015). Even though more study is warranted regarding the importance of maternal education as a correlate of double burden of malnutrition, the direction of its relationship was aligned with how it may impact child stunting.

Interpersonal Level

Family size

One of correlate of double burden of malnutrition in the interpersonal level was family size. A study in an Argentinian population revealed that households with SCOWT tended to have more people living in the house (Bassete et al., 2014). Large family size also correlated with MCBD, where having more than four people in the family increased the odds in both Indonesian (OR=1.34; 95%CI=1.28-1.40) and Bangladeshi population (OR=1.94; 95%CI=1.77-2.12) (Oddo et al., 2012). This large family size was eventually the result of higher maternal parity and high number of siblings in the household. A study in Guatemala showed that households where the

mothers have a higher parity have higher likelihood of undergoing SCOM (OR=1.2, 95%CI=1.1-1.3) (Lee et al., 2010). More siblings in the household were also reported to be a significant predictor of SCOWT in a study involving lower and middle-income countries (Jehn & Brewis, 2009).

Household food security

While food insecurity was largely associated with child stunting (Lee et al., 2012; Restrepo-Méndez et al., 2015), evidence showing food insecurity as a predictor of double burden of malnutrition remains scarce. Indirectly, ecological evidence showed that food insecurity was not necessarily associated with double burden of malnutrition. A study in 2012 revealed that the prevalence of double burden of malnutrition was the highest among the middle quintile of per capita consumption (22.7%) despite the fact that the prevalence of child stunting was the highest among the first quintile (70.4%), and maternal overweight was the highest among the fifth quintile (53.2%) (Lee et al., 2012). Arguably, in the third quintile of per capita consumption, there was not enough of an indication that the households suffered form of food insecurity. Furthermore, we hypothesize that in contrast to child stunting, double burden of malnutrition was likely to occur in households that possess some form of food security or have access to an adequate quantity of food, but food may lack nutrient quality.

Household dietary diversity

At the interpersonal level, a correlate of double burden of malnutrition was partly represented by household dietary diversity. Some studies have shown that dietary diversity score (DDS) is positively related to weight-for-age z-score ($P<0.001$), height-for-age z-score

(P<0.005) (Ey Chua, Zalilah, Ys Chin, & Norhasmah, 2012) and that the higher the dietary diversity, the lower the likelihood of double burden of malnutrition (Deleuze, Fayomi, & Delisle, 2005). A study in rural Malaysia revealed that dietary diversity in households with and underweight child and overweight mother pair was relatively low (Ihab et al., 2013). Among the diverse food groups, foods containing high growth-promoting nutrients are essential to prevention of the double burden of malnutrition. A cross-sectional study in an Indonesian population showed that when consumption of the "high-animal products" was in the highest quartile, the risk of maternal-child double burden decreased (aOR=0.46; 95%CI=0.21-1.04) relative to those in the lowest quartile (Sekiyama et al., 2015). The high-animal products are specifically high in growth-promoting nutrients such as protein, calcium and zinc.

Organizational Level

A shift in the workplace environment

There is dearth of evidence associating double burden of malnutrition with a shift in the workplace environment, with limited opportunity for physical activity. Changes in the environmental settings and type of work were reported to be a significant factor in increasing rate of overweight and obesity (Lee, McAlexander, & Banda, 2011). The amount of physical activity in the workplace declined with the shift from physical labor to sedentary work (Lee, et al., 2011). Work-related physical activity and BMI among an Indonesian population showed that those with sedentary work were at the highest percentage of overweight, even compared to those who were unemployed (Roemling & Qaim, 2013). Furthermore, Roemling and Qaim showed that the prevalence of obesity was similar between people with light work, sedentary, and housekeeping work (Roemling & Qaim, 2013). This illuminates the hypothesis that a housewife

who does mostly housekeeping work is at risk of overweight and obesity. If the effort to eliminate child malnutrition were failing in a country, inactivity among housewives might be a driving force of the increasing prevalence of the double burden of malnutrition (Dieffenbach & Stein, 2012).

Community Level

Rural and urban area

In the socio-ecological model, both rural (Oddo et al., 2012) and urban settings (Lee et al., 2012) are associated with the double burden of malnutrition. Prevalence measured as SCOM in rural Guatemala in 2000 was 19%, while in the urban area was 13.4% (Lee et al., 2012). The adjusted OR showed no significant difference in this population (Lee et al., 2012).

In urban areas, the increased prevalence of overweight and obesity drive the increased rate of double burden of malnutrition. The incidence of overweight and obesity was higher in urban than rural areas in Indonesia (Sandjaja et al., 2013; Vaezghasemi et al., 2014), Mauritius (Caleyachetty et al., 2012) and Malaysia (Khambalia, Lim, Gill, & Bulgiba, 2012). However, the increase was not exclusive to urban areas. Increased prevalence of overweight was observed in both poor rural and urban women in Bangladesh (Shafique et al., 2007).

Contrary to the popular belief regarding "obesogenic" environment being largely embedded within urban settings, evidence from Latin American countries suggests that double burden of malnutrition was more prevalent in rural settings. A study about the double burden of malnutrition in Columbia showed that the prevalence of child stunting was highest in rural areas (Galiano, Abril, Ernert, & Bau, 2012). Similarly, the prevalence of coexistent maternal central adiposity and child stunting (MCA) in a Mexican population was higher in rural areas (Barquera

et al., 2007). These studies might be biased by large indigenous populations in rural areas, which are prone to experiencing the double burden of malnutrition.

Policy

Economic development

The double burden of malnutrition was believed to affect populations undergoing economic improvement as opposed to low-income populations. The association between double burden of malnutrition measured as SCOWT and per capita GDP supports the hypothesis that economic development increased the likelihood of SCOWT (Garrett & Ruel, 2005). Analysis of the Demographic and Health Survey (DHS) data from Latin American countries showed that the prevalence of stunting was the highest in poorer countries, while the prevalence of overweight was highest in countries with growing economies (Tzioumis & Adair, 2014). There is growing evidence that the problem of double burden of malnutrition in a household affects mostly countries with a middle level of gross domestic product (GDP). The prevalence of double burden households is highest in the middle gross national product (GNP) countries (Doak et al., 2005). The double burden of malnutrition arguably started among rich populations, but shifted toward the poorest population group in Indonesia (Roemling & Qaim, 2013). At the household level, a study in Indonesia showed that the double burden of malnutrition was more prevalent in households with a high socioeconomic status (SES) (Vaezghasemi et al., 2014). A study of indigenous populations showed opposite results (Wong et al., 2015; Lee et al., 2012). A study in indigenous Peninsular Malaysia showed that households with income per capita of less than USD 29.01 were associated with increased risk of SCOWT (Wong et al., 2015). A similar finding was observed among indigenous Guatemalans, where SCOWT pairs were more prevalent

among the low and middle SES households (Lee et al., 2012). Further, multivariate logistic regression showed that households at the middle consumption quintile have a higher likelihood of having SCOM, compared to households in the first quintile (aOR=1.74; 95%CI=1.13-2.67) (Lee et al., 2012).

Food policy

To the best of our knowledge, no studies have specifically addressed food policy as correlates of the double burden of malnutrition. With the open-market policy and globalization, some argue that the power of transnational industries will affect the pace of nutrition transition in countries with flourishing economic development. Furthermore, as countries undergo the nutrition transition, the problem of double burden of malnutrition is likely to increase. The increases in obesity for the last 3 to 4 decades in almost all countries seem to be driven mainly by changes in food composition and availability (Morris, Beilharz, Maniam, Reichelt, & Westbrook, 2015) through the global food system that produces more processed and affordable food (Swinburn et al., 2011). Data from FAO in 2006 collected from six developing countries showed that there was an increasing trend in dietary energy availability from 1970 to 2000 (FAO, 2006).

The problem with influx of relatively affordable energy-dense food has been negated in several countries through food taxation policy. Edible oil pricing policies were changed a number of times in China between 1991 and 2000 to influence dietary composition toward less fat (Ng, Zhai, & Popkin, 2008). Another food taxation such as the soda taxation policy in Mexico since 2014 showed that 10% increase in the price of a soda beverage decreased consumption by 10-13% (Kroker-Lobos et al., 2014). Such policies provide promising tools to prevent

obesogenic environments, but challenges from the food industry and implications for international trade are significant. Since the problem of double burden of malnutrition is partly made up from the rise of overweight and obesity, food policies in developing countries should also emphasize as potential strategies to inhibiting obesogenic environments.

Urbanization

Popkin has argued that the double burden of malnutrition in one household is related to urbanization (Popkin, 2002). As urbanization happened, households increased their level of income and food became more available in greater quantity, but not in quality. In China, urbanization was solely responsible for decreased daily energy expenditure by about 300 to 400 kcal per day, while going to work by car/bus contributed a 200 kcal per day reduction in calorie requirement (James, 2008). The characteristics of an "urban" diet were calorie-dense foods, dominated by fat and sugar (Zeba, Delisle, & Renier, 2014). A study in urban poor settings in Kenya indicated that one of the distinct characteristics of urbanization was a high reliance on street food that was energy-dense (Kimani-Murage et al., 2014). The food was high in energy but low in micronutrients and protein, affecting child growth, especially height. When children did not receive enough micronutrients and protein in the first two years of life, they had a tendency to become stunted. Mothers who consumed high-energy food accompanied by low physical activity tended to be overweight.

Table 2.1 Studies with correlates of double burden of malnutrition

Study	Sample	Level of DBMN	Correlates	Significance, OR or 95%CI	Key findings
Barquera et al 2007	Mexican (n=6225)	Household level	Race and genetic (indigenous families)	.	The prevalence of coexistence of maternal central adiposity and child stunting (MCA) in Mexican population was higher among indigenous families
Barquera et al 2007	Mexico (n=6225)	Household level	Rural Area		The prevalence of coexistence of maternal central adiposity and child stunting (MCA) was higher in rural areas
Bassete et al, 2014	Argentina (n=136)	Household level	Family Size		Household with SCOWT tended to have more people living in the house
Bouzitou et al 2005	Benin (n=148)	Community level	Household's dietary diversity		Higher dietary diversity lowered the likelihood of double burden.
Doak et al 2005	(n=39894)	Country level	Economic development		Double burden of malnutrition in a household affected mostly in countries with middle level of gross domestic product (GDP)
Galiano et al 2012	Columbia (n= 1168)	Country level	Rural Area		The prevalence of child stunting was the highest in rural areas
Ihab et al, 2013	Malaysia (n=223)	Household level	Household's dietary diversity		The household's dietary diversity of underweight child and overweight mother pairs was relatively low
Jen and Brewis, 2009	(n=38583)	Country level	Low Maternal Education		Analysis of DHS dataset from 18 lower and middle-income countries showed that low level of maternal education increased the likelihood of SCOWT
Jehn and Brewis, 2009	(n=38583)	Country level			Having more siblings in the households was also reported to be a significant predictors of SCOWT in a study involving lower and middle-income countries
Lee et al, 2010	Guatemala (n=2261)	Community level	Race and genetic	(OR=2.0, 95%CI=1.3-3.1)	Being an indigenous person doubled the risk of SCOWT

			(indigenous families)		
Lee et al 2010	Guatemala (n=2261)	Household level	Maternal short stature	(aOR=3.1, 95%CI=2.1-4.7)	Maternal short stature is a risk factor for SCOWT
Lee et al, 2010	Guatemala (n=2261)	Country level	Family Size	(OR=1.2, 95%CI=1.1-1.3)	Households where the mothers had a higher parity had higher likelihood of undergoing SCOM
Lee et al, 2010	Guatemala (n=2261)	Household level	Working mother	(OR=1.7, 95%CI=1.1-2.6)	Having a working mother in the household increased the risk for SCOWT in Guatemalan population
Lee et al, 2012	Guatemala (n=2492)	Household level	Economic development	(aOR=1.74; 95%CI=1.13-2.67)	Households at the middle consumption quintile had a higher likelihood of having SCOM compared to household in the first quintile
Oddo at al., 2012	Indonesia (n=247126)	Country level	Breastfeeding status	OR=0.84 (95% CI: 0.81-084)	When the child was breastfed, the odds of having MCDB were only 0.84 times compared to when the child was not being breastfed
Oddo at al., 2012	Bangladesh (n=168317)	Country level	Breastfeeding status	OR=0.55 (95% CI: 0.52-0.58)	The protective effect of breastfeeding was even greater in Bangladeshi population where the OR of having MCDB was only 0.55 (95% CI: 0.52-0.58)
Oddo at al., 2012	Indonesia (n=247126)	Country level	Maternal short stature	2.32 times (95% CI: 2.25 – 2.40)	The Indonesian data showed households that had a mother short in stature increased the OR for MCBD 2.32 times (95% CI: 2.25 – 2.40)
Oddo at al., 2012	Bangladesh (n=168317)	Country level	Maternal short stature	OR=2.11 (95% CI: 1.96-2.26)	In Bangladeshi population maternal short stature increase the likelihood of MCBD with OR=2.11 (95% CI: 1.96-2.26).
Oddo at al., 2012	Indonesia (n=247126)	Country level	Family Size	(OR=1.34; 95% CI: 1.28-1.40)	Large family size also correlated with MCBD, where having more than 4 persons in the family increased the odds in Indonesia
Oddo at al., 2012	Bangladesh (n=168317)	Country level	Family Size	(OR=1.94; 95% CI: 1.77-2.12).	Large family size also correlated with MCBD, where having more than 4 persons in the family increased the odds in Bangladeshi population

Oddo et al., 2012	Indonesia and Bangladesh	Country level	Rural Area		Double burden of malnutrition also occur in rural setting
Ramirez-Zea et al 2014	Guatemala (n=44739)	Household level	Race and genetic (indigenous families)		Higher prevalence in SCOWT pairs in indigenous households (28.2%) than non-indigenous households (14.4%)
Roemling and Qaim 2013	Indonesia (n=27327)	Country level	Economic development		The double burden of malnutrition arguably started among the rich population, but recently shifted toward the poorest population group in Indonesia
Sekiyama et al. 2015	Indonesia (n=242)	Household level	Household's dietary diversity	(aOR=0.46; 95%CI=0.21-1.04)	When consumption of the "high-animal products" was in the highest quartile, the risk of maternal-child double burden was decreased, compared to those in the lowest quartile
Vaezghasemi et all, 2014	Indonesia (n=12048)	Household level	Economic development		At the household level, the double burden of malnutrition was more prevalent in households with a high SES
Wong et al 2015	Malaysia (n=160)	Household level	Maternal education	aOR=1.7, $P<0.05$	Mother with higher education was associated with higher odds of SCOWT among indigenous people of Peninsular Malaysia
Wong et al 2015	Malaysia (n=160)	Household level	Ethnicity	aOR=0.1, $P<0.05$	Ethnicity was associated with double burden of malnutrition measured as Underweight Child and Overweight/Obese Mother
Wong et al 2015	Malaysia (n=160)	Household level	Number of children	aOR=0.3, $P<0.05$	Number of children in the household associated with double burden of malnutrition measured as Underweight Child and Overweight/Obese Mother
Wong et al 2015	Malaysia (n=160)	Household level	Older age mother	aOR=1.2, $P<0.05$	Having older aged mother was associated with double burden of malnutrition, measured as SCOWT
Wong et al 2015	Malaysia (n=160)	Household level	Household income per capita	aOR=16.8, $P<0.01$	Having household income per capita of less than $29.01 USD was associated with double burden of malnutrition measured as SCOWT

Potential Intervention Strategies

Using the socio-ecological model, we suggest several targets and settings for an intervention aimed at the double burden of malnutrition (Table 2).

Table 2.2 Potential intervention targets/settings and strategies that utilize a socio-ecological approach

SEM Level	Targets/Settings	Intervention strategies
Individual	Pregnant and lactating women	Empower women especially pregnant and lactating women though nutrition education on healthy eating, exclusive breastfeeding and serving size (Wong et al., 2015; Vaezghasemi et al., 2014; Haddad, Cameron, & Barnett, 2015; Fallah et al., 2013)
		Promoting the importance of nutrition in 1,000 days of early life to break the cycle of intergenerational malnutrition (Haddad et al., 2015)
	Mother	Improve women education attainment
Interpersonal	Household	Promote family planning program
		Improve dietary diversity in the household (Sekiyama et al., 2015)
		Decrease inequalities in household's food distribution (Roemling & Qaim, 2013; Kulsum, Lakshmi, Prakash, 2008)
Organizational	Workplace environment	Promote physical activity in the work place (Siddiqui, Nessa, & Hossain, 2010; Júdice, Hamilton, Sardinha, & Silva, 2015; Shrestha, Ijaz, Kukkonen-Harjula, Kumar, & Nwankwo, 2015).
	Housewife	Create peer group of housewife to reduce excess sedentary time
Community	Rural area	Lobby government to emphasize rural development as a strategy for poverty reduction (Haddad et al., 2015)
		Provide culturally accepted nutrition education to the indigenous population living in rural area
	Urban area	Advocate the local city government to increase parks and recreational space (Lee et al., 2011)
Policy	Food policy	Advocate to the government towards taxation for unhealthy food policy (Kroker-Lobos et al., 2014; Ng et el., 2008)
	Urbanization	Lobby government to emphasize rural development as a strategy for poverty reduction (Haddad et al., 2015)

First, we emphasize that tackling the problem of double burden of malnutrition should be seen as a holistic process. Multiple levels of the SEM approach should be addressed at the same

time, because of the connections between levels. At the individual level, we argue that the mother plays a key role in preventing the double burden of malnutrition for herself and her family. Hence, empowering women to take care of the household in the direction that supports healthy food choice and availability seen to be critical (Haddad, et al., 2015; Vaezghasemi et al., 2014). Evidence shows that maternal education mitigates the rate of double burden of malnutrition (Leroy et al., 2014). Therefore, educating women will lay the groundwork for follow-up interventions targeting women who may become mothers. Improvement in nutrition literacy is among the recommended strategies for addressing the double burden of malnutrition among the Malaysian population (Wong et al., 2015). An educated mother will be more receptive to programs and interventions such as the 1,000 days of early life, safe motherhood, and balanced diet. When mothers understand the benefit of proper nutrition during the 1000 days of early life, they may be more mindful of providing nutritious food for themselves starting from pregnancy through the lactation period (Haddad et al., 2015). Attempts should be made to break the cycle of malnutrition, seen in conditions such as child stunting. Evidence has shown that maternal short stature was associated with increased likelihood of the double burden of malnutrition (Oddo et al., 2012; Lee et al., 2010). Hence, improving nutritional awareness, knowledge, self-efficacy and outcome expectation play the key role in behaviorally oriented nutrition education (Fallah, Pourabbas, Delpisheh, Veisani, & Shadnoush, 2013; Kim & Kim, 2015), and along with food fortification and supplementation (Prawirohartono, Nyström, Ivarsson, Stenlund, & Lind, 2011) strategies will benefit the health of the future generation.

At the interpersonal level, inequalities in food distribution within the household should be minimized and healthier food for all should be promoted. A study in Indonesia revealed that residing in an urban location increased intra-household nutritional inequality (Roemling & Qaim,

2013). Similar results were shown in an urban population in Mysore, India, where the energy intake was more or less equal among family members, but parents tend to consume more adequate protein than children (Kulsum, et al., 2008). In addition to food distribution, emphasis should be placed on improving the type and quality of foods brought to the family table. Household dietary diversity should be promoted with by emphasizing differences in nutritional needs of each family member. For example, to prevent double burden of malnutrition, children should be given foods high in the growth-promoting nutrients such as animal products to prevent stunting (Sekiyama et al., 2015), while mothers should be encouraged to eat healthy food such as fruits and vegetables to prevent overweight and obesity (Pem & Jeewon, 2015). Family planning programs should be encouraged and promoted because evidence shows that a large family is associated with double burden of malnutrition (Jehn & Brewis, 2009; Lee at el. 2010).

At the organizational level, modernization has led the workplace to be more sedentary than the previous decades (Lee, et al., 2011). Some study authors have been proposing strategies for minimizing sedentary time during working hours such as intermittent physical activity breaks by walking to get a drink of water or a snack (Júdice et al., 2015; Shrestha, 2015). In a recent study, excessive time spent in front of TV, computers and video games, known as screen time was significantly associated with BMI gain (Falbe et al., 2013). Therefore, in developing countries where most mothers are housewives, enormous screen and sitting time should be limited. A study in Malaysia showed that being a housewife was associated with physical inactivity with adjusted odd ratio (aOR) of 1.78 (95%CI=1.56-2.03) (Ying et al., 2014). Having a peer group committed to doing physical activity in their spare time would encourage mothers to focus on their health.

At the community level, changes in the built environment are inevitable due to economic development and mechanization in both rural and urban areas. Double burden of malnutrition was reported in both of these areas partly due to the increase of obesogenic environment (Lee et al., 2012). In rural areas advances in technology and mechanization has reduced the amount of physical labor required for many jobs and have decreased activity levels of many workers (James, 2008). To account for the decline in caloric expenditure derived from physical labor, physical activity should be promoted as part of a healthy life (Siddiqui, et al., 2010). In urban areas, an increase in availability of convenience foods is a contributing factor in the rise of overweight and obesity convenient foods (Kimani-Murage et al., 2015). High rates of urbanization and the growth of large cities may be a double-edged sword, because it allows for the expansion of retail marketing of healthy and unhealthy foods (Haddad et al., 2015). Unfortunately, many convenience foods, either from street vendors or fancy food chains are high in calories (Kimani-Murage et al., 2014). Consumption of high-calorie foods combined with more sedentary work common in urban areas, has increased the prevalence of overweight and obesity in developing countries.

The indigenous community requires special consideration because of the peculiar pattern of correlates of double burden of malnutrition. Interestingly, indigenous populations in rural Latin America such as Mexico (Barquera et al., 2007) and Guatemala (Lee et al., 2012) are at higher risk for double burden of malnutrition. Similarly, in an indigenous population in Peninsular Malaysia higher risk of double burden of malnutrition was associated with lower per capita income (Wong et al., 2015). Whether this anomaly was due to genetic traits in the indigenous population has yet to be examined. Nonetheless, providing culturally accepted

nutrition education to indigenous populations living in rural areas might be a good starting point for an intervention.

At the policy level, several countries have implemented taxation policy for energy-dense foods such as vegetable oil and soft drinks. This policy should be maintained and expanded to other unhealthy foods to reinforce community-level interventions to address healthy eating. For example, the Chinese policy to increase price of edible oils might trigger a shift in dietary composition from fat towards proteins and complex carbohydrates (Ng et al., 2008).

To prevent further influx of urbanization, rural areas should be developed equally with, if not more than, urban cities. Countries undergoing urbanization in Africa, such as Kenya (Kimani-Murage et al., 2015) and Egypt (Kavle et al., 2015) should promote dietary diversity and quality while implementing policies to address excessive consumption of energy-dense junk foods. One strategy proposed to prevent double burden of malnutrition was reductions of inequality and poverty (Haddad et al., 2015). More good-paying jobs in rural areas, would minimize inequality and slow urbanization.

Economic development experienced in some middle-income countries provides a good opportunity for food security, but food security assessed as the availability of food in quantity alone might not be adequate to prevent the double burden of malnutrition. Unlike households facing only the problem of child stunting, households undergoing double burden of malnutrition seem to have the capacity to access food, but have a problem choosing healthy foods that are lacking within the household. Food security in these households might promote double burden of malnutrition when a household is spending money on less nutritious food. Consumption of energy-dense foods lacking in growth-promoting nutrient does not prevent child stunting but instead may lead to excess weight gain, overweight and obesity. Therefore, providing mothers in

charge of household food spending with knowledge, skills-set, motivation and self-efficacy of healthful eating can be influential in preventing the double burden of malnutrition. An intervention study targeting low-income, overweight and obese mothers to improve food choices, fat-consumption habits, and physical activity in their 1- to 3-year-old children, has shown promise (Klohe-Lehman et al., 2007).

In this literature review we aimed to describe correlates of the double burden of malnutrition using the socio-ecological model. Correlates are factors associated with the double burden of malnutrition, but not necessarily determinants that imply causation (Bauman, Sallis, Dzewaltowski, & Owen, 2002). The majority of evidence relating to the double burden of malnutrition is brimming with findings of significant cross-sectional associations between a range of individual, interpersonal, organizational, community and policy-level variables. Since these were correlational studies, the observed relationships do not support causal inferences, but may induce hypotheses for further study.

Because the double burden of malnutrition is a complex phenomenon, the socio-ecological model was successful in depicting the relationships among the correlates of the double burden of malnutrition in across multiple levels. Currently, the evidence regarding correlates of double burden of malnutrition is dominated by research at the individual and interpersonal levels. Much of the evidence for organizational, community, and policy levels is based on studies pertaining to overweight and obesity. Hence, some have argued that statistically, double burden of malnutrition such as SCOWT pairs are not independent from the components of maternal overweight and childhood stunting but depend heavily on the prevalence of overweight mothers (Dieffenbach & Stein, 2012). Others have argued that the SCOWT phenomenon can be best explained as a consequence of rapid secular increases in maternal weight (Jehn & Brewis, 2009).

Further study is warranted to illuminate whether the broader layers in the socio-ecological model such as rural and urban settings, a shift in the workplace environment, economic development, food policy and urbanization are indeed a significant predictors of the double burden of malnutrition and not merely overweight and obesity.

Even though some have suggested that the double burden of malnutrition in the form of stunted child and overweight mother pairs (SCOWT) is merely a statistical artifact (Dieffenbach & Stein, 2012), the health and economic consequences are real and devastating. The consequences of the double burden of malnutrition raise public health concerns, starting with the increase of the burden of disease due to under-nutrition. Simultaneously, over-nutrition will lead to increase of non-communicable diseases (NCD) including obesity, cardiovascular disease and hypertension. In fact, NCDs account for 80% of the total burden disease mortality in developing countries, it is estimated that economic production of $84 billion in USD will be lost from heart disease, stroke, and diabetes alone (Abegunde, Mathers, Adam, Ortegon, & Strong, 2007). Hence, it is assumed that the double burden of malnutrition is burdening the already inadequate and overextended health budgets of developing countries (Delisle, Agueh, & Fayomi, 2011).

This narrative review is intended to describe correlates of double burden of malnutrition in the context of the socio-ecological model. Once there is sufficient evidence to describe correlates on all levels of the SEM through a systematic review or meta-analysis, a more objective picture of the double burden of malnutrition will emerge. Limitation for this narrative review include the restriction of article inclusion in English language and dependence on the coverage of PubMed database coverage. Some relevant studies and grey literatures might not be captured using this search strategy, and that could affect the current narrative. Though evidence was limited for the double burden of malnutrition at the organizational, community, and policy

levels of the SEM, this review explained the impact of those levels adequately using correlates of overweight and obesity. Considering that overweight and obesity is part of the puzzle in the double burden of malnutrition, we do not expect the effect of the correlates to be much different. We realize that by understanding double burden of malnutrition through the socio-ecological model means our effort to tackle double burden of malnutrition cannot be spatial. Furthermore, we offer some potential intervention strategies based on the SEM that might be useful for future interventions.

Conclusion

The double burden of malnutrition is a public health phenomenon associated with an array of socio-ecological determinants. Implementation of an integrative model such as the SEM offers a potential solution for combating the complex problem of the double burden of malnutrition. Correlates at each level should be addressed holistically and efforts can target individuals, households, organizations, communities, and governments. Addressing malnutrition in all its forms requires an integrated approach to address the root causes of malnutrition at all stages of human development.

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Chapter 3 - Household Dietary Diversity and Child Stunting in East Java, Indonesia

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Abstract

Background: More than one-quarter of under-five children in the developing world are stunted, and those with poor nutrient intake are at risk of irreversible cognitive impairment. The purpose of this study was to determine the relationship between dietary diversity and child stunting in an Indonesian context. *Methods:* Dietary diversity was assessed using a maternal-reported checklist of 12 food groups, summed as a Household Dietary Diversity Score. Stunting was defined as ≤-2.0 height-for-age z-score by WHO-Anthro 2005. Trained interviewers administered the household dietary diversity questionnaire to 768 households with children aged <5 years in East Java, Indonesia. Logistic regression models were constructed to test the association between dietary diversity and child stunting. *Results:* The prevalence of child stunting was 39.4%, and the percentage of households consuming food groups high in protein and calcium like dairy products (41%), and meat/poultry (65%) was lower compared to other food groups. The unadjusted model revealed that higher dietary diversity scores were associated with lower likelihood of child stunting (OR=0.885; 95%CI=0.799–0.980). This relationship remained significant after adjustment for family size, maternal literacy, food expenditure, breastfeeding, energy, and protein intake (OR=0.892; 95%CI=0.802–0.993). *Conclusions:* The

dietary diversity score was moderate, with consumption of dairy products and meat/poultry lowest among 12 food groups. Hence, population interventions should focus on promoting food groups currently lacking in maternal and child diet, including those rich in growth-promoting nutrients like dairy, meat/poultry. These results, from an Indonesian context, confirm the widely observed protective relationship between dietary diversity and child stunting.

Keywords: dietary diversity, child stunting, malnutrition, food pattern, Indonesia

Introduction

Childhood stunting is a major nutritional problem in developing countries (World Health Organization [WHO], 2013a). Stunting is defined as height-for-age z-score below -2.0, using the current World Health Organization (WHO) standards from the Multi Growth Reference Study (WHO, 2006). In 2011, around 26% of world's children under the age of five years were stunted (WHO, 2013a). Based on the United Nations Children's Fund (UNICEF) conceptual framework on malnutrition, nutritional status is influenced by three broad factors: food, health, and care (the United Nations Children's Fund [UNICEF], 2013). Stunting is caused by long-term insufficient nutrient intake (Save the Children, 2012), and frequent infections (UNICEF, 2013). There is an association between childhood stunting and suboptimal brain development, which might impair children's cognitive ability, school performance, and potential earning when they enter the workforce (UNICEF, 2013; WHO, 2013a; WHO, 2006). The WHO report of a colloquium on childhood stunting highlighted the importance of the 1,000-day period (from conception to 24 months of age) when the foundation is laid for an individual's physical size, as well as their physiological and intellectual capacities in later life (WHO, 2013b). With detrimental effects of

child stunting, many countries affiliated with The World Health Assembly have committed to achieve 40% reduction by 2025 through the Scaling up Nutrition (SUN) program (UNICEF, 2013). Among the three groups of priority policy responses in the SUN framework are nutrition-specific intervention. This intervention has nutritional improvement as the primary goal, and should be accessible to all individuals and their households, especially from pregnancy to the first two years of life, and at times of illness or distress (Scaling-Up Nutrition [SUN], 2010). To prevent a lifetime of lost potential due to stunting, emphasis should be placed on the importance of providing a supportive nutritional environment through timely and appropriate complementary feeding during the first 1,000 days of life (Save the Children, 2012; SUN, 2010; WHO, 2013a), that involves a diverse diet (Parlesak, Geelhoed, & Robertson, 2014; Darapheak, Takano, Kizuki, Nakamura, & Seino, 2013; Sunguya et al., 2013; Mallard et al., 2014).

One method of assessing dietary quality employs the dietary diversity score (Drewnowski, Henderson, Shore, Fischler, Preziosi, & Hercberg, 1996). The dietary diversity score (DDS) measures the sum of diverse food categories, irrespective of the amount consumed individually for the last 24 hours (Steyn, Nel, Nantel, Kennedy, & Labadarios, 2006; Food and Agriculture Organization of the United Nations [FAO], 2010). The DDS, as measured by a quantitative number of food groups, has become a widely used method of determining variety in the diet, and by proxy, nutrient adequacy (Steyn et al., 2006). Several classification systems have evolved in determining DDS with the number of food groups varying from 7 (Wright, Bentley, Mendez, & Adair, 2015), 8 (Steyn, Nel, Labadarios, Maunder, & Kruger, 2014), 9 (Steyn et al., 2006; FAO, 2010) to 12 groups (FAO, 2010).

One of the major nutritional problems in the diets of developing countries is the lack of dietary diversity, mainly comprising plant-based food sources, but with limited intake of fruits

and vegetables (Ochola & Masibo, 2014). Dietary quality and diversity have changed; secondary data analysis in 6 developing countries showed that the trend in dietary energy availability steadily increased from 1970 to 2002 (FAO, 2006). Increases in dietary energy availability were likely due to the increased consumption of edible oil, and in fats as percentage of dietary consumption (Ng & Popkin, 2008; Popkin, 2004).

Several studies have reported that low dietary diversity is associated with increased likelihood of child stunting (Labadarios et al., 2011), and double burden of malnutrition (Deleuze Ntandou Bouzitou, Fayomi, & Delisle, 2005). A low DDS also has been associated cardiovascular risk (Truthmann, Richter, Thiele, Drescher, Roosen, & Mensink, 2012), dyslipidemia (Li et al., 2011), and higher probability of metabolic syndrome (Azadbakht, Mirmiran, Esmaillzadeh, & Azizi, 2006). While food insecure-households have been linked with negative nutrition outcomes such as poor linear growth and child stunting (Larrea & Kawachi, 2005), the association between food insecurity and child stunting was independent with regard to dietary diversity, especially in semi-arid areas (Bukania et al., 2014). Previous studies in Southeast Asia have been mixed regarding the association between dietary diversity and child stunting. A study in a Malaysian indigenous population showed that better dietary diversity was associated with less likelihood of child stunting (Ey Chua, Zalilah, Ys Chin, & Norhasmah, 2012), while a similar study in rural Cambodia showed no significant association (McDonald, McLean, Kroeun, Talukder, Lynd, & Green, 2014).

A study in Ethiopia revealed that the dietary diversity among school-aged children was low, and even though not statistically tested in relation to dietary diversity, the article did highlight that the school-aged children were also lacking in animal-source food (ASF) intake (Herrador et al., 2015). In Ethiopia, intake of ASF was a protective factor against stunting

(Herrador et al., 2014a) and zinc deficiency (Herrador et al., 2014b). One might argue that the low dietary diversity score was driven mainly by the lack of ASF intake that was found to have a wide array of micronutrients essential for enriching type II nutrients (the growth nutrients) such as: vitamin A, vitamin B-12, riboflavin, calcium, iron and zinc (Lanou, Berkow, & Barnard, 2005). Specifically, zinc is an essential trace element with special importance in the immune system (Kloubert & Rink, 2015). A study of Peruvian infants showed an association with poor growth when the body has a prolonged short supply of these micronutrients (Iannotti, Zavaleta, León, Shankar, & Caulfield, 2008). The immune system might also be depressed due to inability of low fat mass to secrete leptin that helps stimulate immune system (Briend, Khara, & Dolan, 2015). Due to a weakened immune system, it is believed that children are prone to repeated bouts of infection, and thereby become stunted (UNICEF, 2015). Therefore, sufficient intake of ASF increases fat stores and provides nutrients that are essential for growth and micronutrients that support the immune system (Herrador et al., 2015).

The prevalence of child stunting in Indonesia was 36.8%, 35.6% and 37.2% in 2007, 2010 and 2013, respectively (Balitbangkes, 2013). Some have suggested that the East Java Province is a microcosm of Indonesia in terms of child health outcome achievement in Indonesia. Based on the data of Indonesia's Basic Health Research (Riskesdas), the prevalence of stunting in East Java increased from 34.8% in 2007 to 35.8% in 2010 (Balitbangkes, 2013). To the best of our knowledge, there is no previous study conducted in East Java specifically, or more generally within Indonesia, a country of 240 million people, to test the hypothesis that dietary diversity decreases the likelihood of child stunting. A previous study involving a population-based sample of 446,473 rural and 143,807 urban children in poor areas in Indonesia showed that higher household expenditure on animal-source and non-grain foods lowers the risk

of stunting among children 0-59 months old (Sari et al., 2010). The study of dietary diversity within an Indonesian context is specifically interesting because of the rapid nutrition transition this country is undergoing that is believed to be the result of shifted food preferences toward modern Western foods (Lipoeto, Geok Lin, & Angeles-Agdeppa, 2013). Indonesia is an archipelago country with rich natural resources that gives vast food source availability compared to previous studies related to dietary diversity and stunting in countries with limited natural resources, like those in sub-Sharan Africa (Bukania et al., 2014; Motbainor, Worku & Kumie, 2015). Studies in the Southeast Asia region with relatively abundant natural resources of food, such as in Cambodia (Darapheak et al., 2013; McDonald et al., 2014) and Malaysia (Ey Chua et al., 2012), only incorporated samples from rural areas, urban areas, or both still producing equivocal results. To strengthen the evidence in Southeast Asian settings, our study includes participants from both rural and urban settings. Even further, we incorporate different types of geographical locations from coastal to mountainous areas. With the magnitude of child stunting in Indonesia and absence of scientific evidence in an Indonesian context, we aim to determine the relationship between dietary diversity and child stunting in East Java, Indonesia.

Methods

A cross-sectional study was conducted in 8 districts representing both urban and rural, as well as coastal and mountainous regions in East Java Province, Indonesia. With an initial sample of 768 households with under-five-year-old children, 736 were included in the final analysis. The sample was determined by using the census block method as follows: three sub-districts were randomly selected from each district/municipality, then two villages were randomly selected from each sub-district, and finally 16 households were randomly selected in every village.

Samples were 96 households in each district/municipality. Consent was obtained from each participant in written form after information regarding the purpose of the study was explained. All identities of the participants were kept confidential.

In this study, a single 24-hour maternal-reported food recall data was applied to the checklist of 12 food groups proposed by FAO (FAO, 2010). Presence or absence of the food groups consumed in the last 24 hours then determined the household dietary diversity score (HDDS). The score is continuous, ranging from 0 to 12, based on whether members of the household consumed any of the 12 food groups in the last 24 hours prior to the interview (Swindale & Bilinsky, 2006). All the food items consumed by the participants were categorized into 12 food groups which were: staple food (rice, cereals), tubers/roots, vegetables, fruits, fish (including dried fish and seafood), meat (including poultry) egg, nuts and seeds, milk (including all dairy products), spices, oils and fats (coconut products were included), and sweets. Trained interviewers administered the HDDS to 768 household members with children aged <5 years in East Java, Indonesia. Children's weight was measured using a standardized electric scale (Camry EB6571, Guangdong China) in at least 0.1 kg increments. Standing height was measured by using Vktech Stature Meter height measure or microtoise in 0.1 cm increments. Stunting was defined as less than -2.0 height-for-age Z-score (HAZ) by WHO-Anthro 2005.

Maternal attributes and socio-demographic factors were measured using a structured face-to-face interview performed by trained interviewers. Maternal attributes included were maternal literacy, and exclusive breastfeeding status. Socio-demographic factors included total monthly expenditure, food expenditure, source of drinking water, number of under-five-year-old children, and family income.

SAS version 9.4 was used for statistical analyses. Logistic regression models were constructed to test the association between HDDS and child stunting. We developed four models of logistic regression to test our hypothesis that better dietary diversity score was a protective factor, or related to decreased likelihood of child stunting in Indonesia. The first model included only household dietary diversity score (HDDS), while the second model also included family size and maternal literacy as covariates. The third model added the food expenditure variable as an estimate of food security. In the fourth and final model, we incorporated all potential covariates (family size, food expenditure, breastfeeding status, total energy intake, and protein intake) to see whether the observed association in the original model was robust. For all statistical analyses, the results were deemed significant if the obtained *P*s were less than 0.05.

Ethical clearance

Prior to the interview and anthropometric measurement, the trained interviewers explained the purpose of the study and asked for oral informed consent from the mothers of the children. This study utilized the Food Security Survey data from the Food Security Board of East Java Province in Indonesia that was anonymous, and was approved by the Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University, USA with proposal number 7955.

Results

Household and environmental characteristics

The characteristics of the households were mostly consisting of a nuclear family, with total number of household members of ≤4 people (55.4%) and the source of drinking water was a

well (80%). Thirty-seven percent of households had 5 to 6 household members living under the same roof. Approximately 65% of households had only one working member of the household. Almost all households had a literate father (92.5%), indicating sufficient capability of understanding written information. The mean monthly family income was 92 USD, which was greater than the mean monthly expenditure (64 USD). Almost 47.8% of the family income was used for purchasing food.

The prevalence of child stunting was 39.4% and the mean household DDS was 9.1, a score falling between moderate and high. More than 90% of the households were consuming staple food (rice; 99.6%), vegetables (97.8%), legumes (99.0%), egg (91.5%), and sweets (91.7%) and fat/oil (99.6%). Wider variation was observed in terms of fruit (64.8%), spices (78.2%), meat/poultry (65.0%) and fish (88.0%) food group consumption. The least consumed food group was dairy products, with only 41.5% of households reporting consumption in the last 24 hours.

Dietary diversity and stunting

Looking at univariate correlations between "non-nutritional" independent variables and child stunting, only food expenditure had a significant association (P=0.042); while family size (P=0.806), source of drinking water (P=0.670), geographical location (P=0.359) and maternal literacy (P=0.341) were not significant. For the nutritionally related independent variables, dietary diversity (P=0.028) and protein intake (P=0.043) was significantly associated with child stunting, while breastfeeding status (P=0.707) and total energy intake was not significant (P=0.158).

Binary logistic regression involving all food groups as independent variables and child stunting as dependent variables showed only consumption of fish (*P*=0.028), spices (*P*=0.042) and meat/poultry (*P*=0.036) were statistically significant (Table 1). Fish consumption consisted of fresh-water fish, salt-water fish, as well as dried fish. In the last 24 hours, the mean consumption of salt-water fish (27.9g, SE=1.3) and dried fish (7.7g, SE=0.6) was higher, compared to fresh-water fish (3.6g, SE=0.4).

Table 3.1 Mean score of individual food group consumed in household for the last 24 hours in association with child stunting

Food Groups	Mean ± SD	*P*	Unadjusted OR	95%CI	
				Lower	Upper
Dairy	0.41 ± 0.49	0.113	1.317	0.937	1.850
Egg	0.92 ± 0.28	0.178	0.673	0.378	1.198
Fish*	0.88 ± 0.32	0.028	1.834	1.068	3.151
Fruit	0.65 ± 0.48	0.187	0.784	0.546	1.126
Legumes	0.99 ± 0.09	0.789	1.254	0.238	6.600
Meat & Poultry*	0.65 ± 0.48	0.036	0.675	0.467	0.975
Oil & Fat	0.99 ± 0.07	0.643	0.561	0.049	6.452
Spices*	0.79 ± 0.40	0.042	0.655	0.436	0.985
Staple (Rice)	0.99 ± 0.05	0.705	0.583	0.036	9.551
Sweet	0.91 ± 0.28	0.897	1.038	0.589	1.830
Vegetables	0.98 ± 0.15	0.367	0.622	0.222	1.746

Note. *Significant at α=0.05 for particular dietary diversity score of food group consumed in the last 24 hours in household with and without stunted children. The unit of the mean and standard deviation on each food groups was based on binary score (0=not consuming; 1= consuming food groups in the last 24 hours).

As shown in Table 2, the chi-squared test within each type of fish consumption and child stunting showed significant association only for dried fish (*P*=0.015). The odds ratio of overall fish group consumption was 1.834 (95%CI=1.068–3.151) indicating fish consumption was a risk factor for child stunting. In contrast, the odds ratio of both spices and meat/poultry group showed inverse associations with child stunting. The odds ratio of spices consumption was 0.655 (95%CI=0.436–0.985), while meat or poultry consumption was 0.675 (95%CI=0.467–0.975).

Table 3.2 Cross tabulation of fish group consumption and child stunting status

Fish Groups		Child Nutritional Status		Chi-Squared Test
		Not Stunted	Stunted	
Salt-water fish	Yes	151 (21.7%)	105 (15.1%)	0.232
	No	279 (40.1%)	160 (23.0%)	
Fresh-water fish	Yes	14 (2.0%)	10 (1.4%)	0.717
	No	416 (59.9%)	255 (36.7%)	
Dried fish*	Yes	30 (4.3%)	33 (4.7%)	0.015
	No	400 (57.6%)	232 (33.4%)	

Note. Fish group in the calculation of dietary diversity score consists of salt-water fish, fresh-water fish and dried fish. *Consumption of dried fish was significantly different at α=0.05 between household with and without child stunting.

All four models in the logistic regression consistently showed significant associations between HDDS and child stunting. The first model used dietary diversity score as a predictive variable, and binary response of stunting or not stunted. There was a significant protective association between DDS and child stunting with OR=0.885 (95%CI=0.799–0.980).

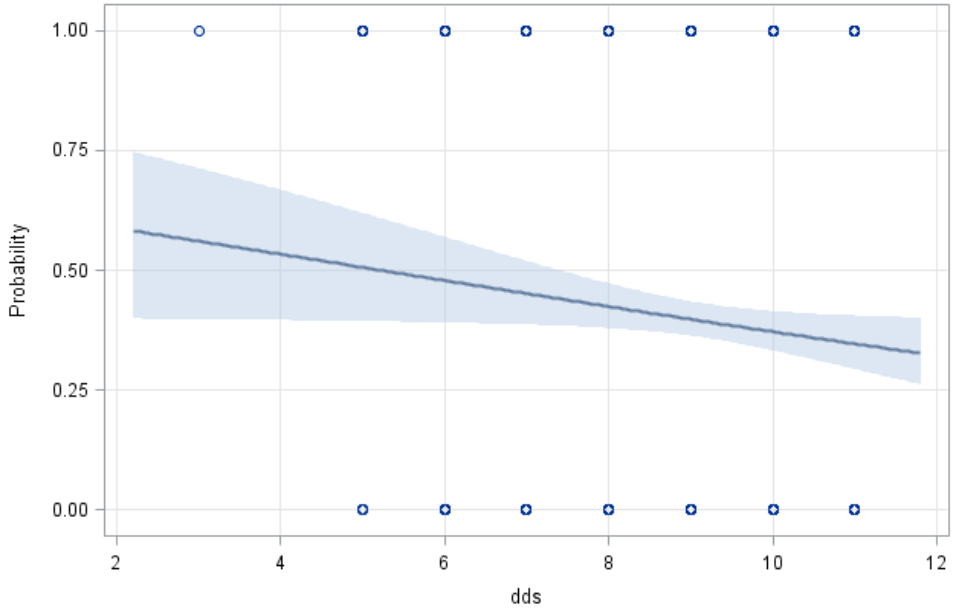

Figure 3.1 Predicted probability for stunting based on the final model (dietary diversity score adjusted for family size, food expenditure, breastfeeding status, total energy intake, and protein intake).

The results of the final model showed that the significant association between HDDS and child stunting persisted across models. The final model showed that HDDS was inversely associated with child stunting with OR=0.892 (95%CI=0.802–0.993). This means that with a one-point increase in household dietary diversity score, the likelihood of child stunting was decreased by more than 10% (Figure 1).

Subsequent logistic regression was performed to stratify our final model with breastfeeding status as: exclusively breastfed (until 4 months), partially breastfed, and not breastfed (Table 3). The results showed only among non-breastfed children that the association between HDDS and child stunting remained statically significant (OR=0.883; 95%CI=0.0783-0.995) adjusted for family size, food expenditure, total energy intake and protein.

Table 3.3 Logistic regression coefficients of predictive power of variables included in the model for child stunting by breastfeeding status

VARIABLE	EXCLUSIVELY BREASTFED (N=62) (UNTIL 4 MONTHS)				PARTIALLY BREASTFED (N=144)				NOT BREASTFED (N=530)			
	P	**OR**	**95% CI**		***P***	**OR**	**95% CI**		***P***	**OR**	**95% CI**	
			Lower	**Upper**			**Lower**	**Upper**			**Lower**	**Upper**
HDDS	0.912	1.024	0.674	1.554	0.426	0.901	0.697	1.165	0.041	0.883*	0.783	0.995
FAMILY SIZE	0.464	1.620	0.446	5.893	0.567	1.258	0.574	2.757	0.363	0.844	0.586	1.217
FOOD EXPENDITURE	0.845	1.146	0.294	4.470	0.252	1.606	0.714	3.609	0.478	1.146	0.787	1.669
ENERGY INTAKE	0.282	1.003	0.998	1.007	0.289	1.001	1.000	1.002	0.736	1.000	0.999	1.000
PROTEIN INTAKE	0.966	0.994	0.763	1.295	0.129	0.971	0.934	1.009	0.341	0.993	0.978	1.008

Note. *HDDS significantly associated with child stunting at α=0.05 only for non-breastfed children in a logistic regression model involving independent variables (family size, food expenditure, total energy intake and total protein intake).

Discussion

The objective of the current study was to determine the relationship between dietary diversity and child stunting in an Indonesian context. Our study confirmed the hypothesis that dietary diversity, as measured using household dietary diversity score, was a protective factor for child stunting. We found a significant protective association between household consumption of meat/poultry and child stunting. The proportion of food groups that was rich in growth-promoting nutrients such as animal protein was low, with only less than 65.0% of households consuming meat/poultry in the last 24 hours. This association aligns with the results of study conducted in Cambodia that showed children who consumed animal source food were less likely to be stunted (Darapheak et al., 2013). A previous study in Indonesia highlighted the association between higher proportions of total household expenditure on animal foods with decreased likelihood of child stunting (Sari et al., 2010). The protective effect of meat consumption was also confirmed in a study focused on infants and toddlers in four diverse low-income countries (Krebs et al., 2011).

Another food group that showed a significant association with child stunting was fish consumption. The effect size of fish group consumption was not aligned with previous studies where fish consumption was negatively associated with child stunting (Baye, Guyot, Icard-Vernière, & Mouquet-Rivier, 2013). We hypothesize that due to the high proportion of dried fish consumption in the present study population, our results were masked by socioeconomic status (SES) of the household. The cheap price of dried fish, compared to freshwater fish, might explain this significant relationship. Our chi-squared analysis within each type of fish consumption also supported our hypothesis where only dried fish was significantly associated with child stunting. In rural areas of Indonesia, consumption of small whole fish with bones,

which are readily available sources of Fe, Calcium, Zn and vitamin A, is often limited because of economic constraints (Wijaya-Erhardt, Muslimatun, & Erhardt, 2011). Similarly, we posit that household spice consumption showing a protective effect toward child stunting was actually an indication of SES. That is, higher SES households were likely to include spices in their meal, compared to the lower SES.

Our first logistic regression model showed a significant unadjusted association between HDDS and child stunting. This relationship remained significant in the final model, after adjustment for family size, food expenditure, breastfeeding status, total energy intake, and protein intake. A similar study using 12 food groups via HDDS in Cambodia showed no significant association, despite a lower mean HDDS score, compared to our study (McDonald et al., 2014). This difference may be due to the study setting in rural Cambodia that was more homogeneous than our study, which incorporated both urban and rural areas, as well as coastal and mountainous regions. Our study showed similar results to another study in Cambodia where stunting was negatively associated with dietary diversity (Darapheak et al., 2013). That study, however, used a measure of 6 food items from seven food groups, according to the WHO's infant and young child feeding (IYCF) model (UNICEF, 2012). The study by Darapheak et al. used data from the Cambodia Demographic and Health Survey (CDHS) in 2005 (Darapheak et al., 2013), which, in terms of population, is more representative than McDonald et al. study (McDonald et al., 2014). Our results were also in accord with a study in a Malaysian setting that showed a negative association between HDDS based on 15 food groups and HAZ (Ey Chua et al., 2012). Outside Southeast Asian countries, significant associations between better HDDS and decreased likelihood of child stunting also have been reported in Bangladesh (Rah et al., 2010), and Ethiopia (Motbainor et al., 2015).

The strength of association between HDDS and child stunting in our study was relatively small (OR=0.892; 95%CI=0.802–0.993) compared to the previous study in Bangladesh for child age 24-59 months (OR=0.69; 95%CI=0.66–0.73) (Rah et al., 2010), but slightly greater than study from Cambodia (OR=0.95; 95%CI=0.91-0.99) (Darapheak et al., 2013). Unfortunately, the odds ratio from the study Malaysian population was not available for comparison (Ey Chua et al., 2012). Relative similarity in the strength of association between study in Cambodia (Darapheak et al., 2013), and our study might be attributable to the fact that both studies incorporated rural and urban settings, while studies in Bangladesh (Rah et al., 2010), were based on rural population only. Rural settings had lower HDDS compared to the urban settings, as food availability in urban sites were more abundant and diverse (Herrador et al., 2015). Subsequent logistic regression with stratification of breastfeeding status showed that the protective effect of HDDS was only true for non-breastfed children (OR=0.883; 95%CI=0.0783-0.995). This finding might be related to the evidence that children who were still breastfed were more likely to have limited diversity (Rah et al., 2010).

The mean household dietary diversity score was 9.1, which can be considered medium to high diversity. This was almost twofold higher than a similar study using HDDS based on 12 food groups conducted in a rural Cambodian population with mean HDDS score of only 4.7 (McDonald et al., 2014). In the present study, six food groups were consumed by more than 90% of the households: rice, vegetables, legumes, egg, sweets and fat/oil. Rice is a staple food of Indonesians that supplies around 70% of total energy. Fat/oil was presumably used for cooking methods such as frying. Rice and oil are a poor source of protein, which promotes child growth and prevents stunting. Legumes were also widely consumed, and are rich in plant protein, but

may have lower bioavailability compared to animal protein. Hence, the ability of legumes to support child growth might not be as robust.

Another food group that was highly consumed was vegetables. Vegetables are nutrient dense with a lot of vitamins and micro-minerals essential for health. In Indonesia, however, cooking methods such as boiling and steaming vegetables might diminish some of valuable water-soluble vitamins when eaten. Fruits, as well as vegetables, are generally nutrient dense, particularly rich in vitamins and minerals that help maintain body metabolism. In our study, only 64.8% of households consumed fruit in the last 24 hours, and this was not a significant predictor of child stunting. The least commonly consumed food group was dairy products, at 41.5% of the households. Dairy products are a prime source of calcium that is essential for bone development and growth. Besides animal protein, dairy's growth-stimulating effect is believed to be insulin-like growth factor 1 (IGF-1) contained in these foods (Michaelsen, 2013). A case-control study in Iran found significantly lower mean dairy intake of stunted children than their normal counterparts (Esfarjani, Roustaee, Mohammadi-Nasrabadi, & Esmaillzadeh, 2013). In our study, however, we did not find a significant relationship between dairy products and stunting.

The prevalence of child stunting in the current study was 39.4%, which was slightly higher than the national prevalence. Since the prevalence of child stunting was way above 5%, it was less likely that the observed stunting was due to "healthy shortness" where child's shortness was attributable solely due to inherited genes and not because of inadequate nutrition or repeated bouts of infection (Prendergast & Humphrey, 2014). Maternal short stature had been associated with child stunting (Ozaltin, Hill, & Subramanian, 2010; Chirande et al., 2015; Hambidge et al., 2012) and lend weight to the healthy shortness narrative. Unfortunately, we did not measure maternal height to test this hypothesis in our study.

In our study, food expenditure was significantly associated with child stunting, while other non-nutritionally related factors such as family size, the source of drinking water and geographical location was not significantly related. Our results conflicted with the study in rural Armenia that showed the association between non-nutritional factors particularly family size with child stunting (Demirchyan, Petrosyan, Sargsyan, & Hekimian, 2015). Unsafe source of drinking water was a risk factor for child stunting in Tanzania (Chirande et al., 2015) but not in our study. We believe our results were affected by the fact that the majority of participants acquired drinking water from a well. Differences in ecological settings and geographical areas seem to be reflected in different dietary diversity, be it in rural (McDonald et al., 2014) or urban (Mallard et al., 2014; Savy, Martin-Prével, Danel, Traissac, Dabiré, & Delpeuch, 2008) settings, as well as in arid and semi-arid area (Segnon & Achigan-Dako, 2014). However, we failed to see such association between geographical locations and child stunting in our study.

The strength of our study includes the implementation of the census block method to capture better representation of diverse geographical areas in East Java Province including rural and urban setting. Further, we incorporated different types of geographical locations from coastal, agricultural lowland, to mountainous areas. Furthermore, the final logistic regression model was used to adjust for several covariates known to have confounding effect on the association between dietary diversity and child stunting, lending credence to the observed associations. Last, this study was administered by trained-interviewers in a manner that maternal literacy would not affect any of the outcomes.

Some limitations should be noted for the interpretation of our findings. This study was cross-sectional, so it does not allow us to infer any causal relationship. The fact that the HDDS calculation was based on a single 24-hours dietary food recall is less robust compared to the

repeated recalls, even for the common dietary measure of total energy (Ma et al., 2009). Some of food groups rich in growth promoting nutrients that have greater daily variation than energy intake might be misreported in a single measure. These include protein (Ouellette et al., 2014), zinc, iron, and calcium (Poslusna, Ruprich, de Vries, Jakubikova, & van't Veer, 2009). Our HDDS was measured based on maternal 24-hours dietary food recall, which may have lower agreement with child's dietary diversity for food groups rich in micronutrients (e.g., dairy, meat/poultry, and fruits and vegetables) (Nguyen et al., 2013). Although we did not go to the extent of making a refined assessment of HDDS to include "quantity" of at least 15 gr/day for a food group to be considered "consumed", we did base our assessment on a 24-hour dietary recall. Hence, we were able to take into account the effect of potential nutritional confounders such as total energy intake and total protein intake. A more rigorous study, using randomized controlled trial or prospective cohort study design, should be implemented to confirm protective properties of dietary diversity and child stunting. Subsequent logistic regression stratified by breastfeeding status showed that the protective association between HDDS and child stunting was only significant among non-breastfed children. It should be considered that stunting is a multifactorial disorder affected not only by dietary factors, but also genetics, birth weight, and metabolic conditions.

Conclusion

In the scarcity of evidence in Indonesian setting, our study added more weight to the hypothesis that better dietary diversity was associated with decreased likelihood of child stunting. These results confirm the widely observed protective relationship between dietary diversity and child stunting. Hence, population interventions should focus on promoting food

groups currently lacking in the maternal and child diet, including those rich in growth-promoting nutrients such as dairy, poultry, and meat.

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Chapter 4 - Household Food Insecurity as A Predictor of Stunted Children and Overweight/Obese Mothers (SCOWT) in Urban Indonesia

Note. Now considered for publication with major revision in the Public Health Nutrition Journal.

Abstract

Objective: To determine the relationship between household food insecurity as measured by the categorization of the household food insecurity access scale (HFIAS) and double burden of malnutrition as indicated by within-household stunted child and overweight/obese mother (SCOWT). *Design:* This was a cross-sectional survey regarding food insecurity and double burden of malnutrition individually administered by trained interviewers in April and May 2015. *Setting:* Urban households were selected through systematic cluster sampling methods from 14 integrated health posts (*posyandu*) in Surabaya, Indonesia. *Subjects:* A sample of 700 households with mothers and at least one child between 2 and 5 years of age were interviewed. Excluding cases with missing data or extreme values, 685 households were analyzed. *Results:* The prevalence of child stunting was 36.5%, maternal overweight/obesity was 58.8%, and SCOWT was 21.2%. Although many households were food secure (42%), there were high proportions of mild (22.9%), moderate (15.3%) and severe (19.7%) food insecurity. In multivariate logistic regression, maternal height and HFIAS category significantly correlated with both child stunting and SCOWT. Greater maternal height in cm decreased the likelihood of both child stunting (OR=0.900; 95%CI=0.867-0.933) and SCOWT (OR=0.876; 95%CI=0.823-0.933). Compared to

the food secure households, moderately food insecure households had the greatest odds of SCOWT (OR=4.541; 95%CI=1.889–10.915), followed by the mildly food insecure (OR=3.707; 95%CI=1.614–8.518) and severely food insecure households (OR=3.151; 95%CI=1.321–7.515). *Conclusions:* These results support the hypothesis that double burden of malnutrition is robustly related to food insecurity, and HFIAS category is a predictor of SCOWT.

Keywords: Food security, HFIAS, Double burden of malnutrition, Child stunting, Indonesia

Background

One of the primary public health problems of the 21st century is an obesity epidemic that affects over half a billion people worldwide (Bhurosy & Jeewon, 2014). In 2008, an estimated 1.46 billion adults were overweight (body-mass index [BMI]>25 kg/m²), with 205 million men and 297 million women among them categorized as obese (BMI>30 kg/m²) (Finucane et al., 2011). Obesity is not solely affecting developed countries; the developing parts of the world also have experienced great increases in prevalence (Bhurosy & Jeewon, 2014). Data from the World Health Organization (WHO) showed that developing countries in Africa and Southeast Asia will soon face the levels of overweight currently prevalent in developed countries such as the USA (Martorell, Khan, Hughes, & Grummer-Strawn, 2000).

On the opposite end of the nutritional spectrum, the prevalence of under-nutrition remains a major public health problem. Although the United Nation's efforts to combat malnutrition through Millennium Development Goals (MDGs) have been progressing toward attainment (Bredenkamp, Buisman, & Van de Poel, 2014) almost half of all deaths among children under the age of 5 years are still attributable to under nutrition (Restrepo-Méndez,

Barros, Black, & Victora, 2015). UNICEF reported that in 2011 more than a quarter of world's children <5 years of age were stunted (United Nations Children's Fund [UNICEF], 2013) and 16% were underweight (UNICEF, World Health Organization [WHO], & the World Bank, 2012). In developing nations, the problem of nutrient deficiencies that manifest in under-nutrition (underweight, wasting, and stunting) still persist, while the problem of over-nutrition such as overweight and obesity increased rapidly. The 2006 FAO report from studies in 6 developing countries referred to this phenomenon as a double burden of malnutrition, where under- and over-nutrition occur simultaneously among different population groups in developing countries (Food and Agriculture Organization of the United Nations [FAO], 2006). Based on the 2013 National Health Survey in Indonesia, the prevalence of double burden of malnutrition is around 11% (Badan Penelitian dan Pengembangan Kesehatan Kementrian Kesehatan RI [Balitbangkes], 2013) with some estimates much higher (Sekiyama et al., 2015).

The double burden of malnutrition has raised public health concerns, due to its consequences. Double burden will manifest with deficiency diseases of under-nutrition, while simultaneously leading to increases in the non-communicable diseases (NCD) of over-nutrition, such as obesity, cardiovascular disease, type 2 diabetes mellitus, and hypertension. The present amount of NCDs accounts for 80% of the total burden of disease mortality in developing countries; an estimated US$84 billion of economic production will be lost from heart disease, stroke, and diabetes alone (Abegunde, Mathers, Adam, Ortegon, & Strong, 2007). Hence, the presence of double burden of malnutrition will continue to burden the already inadequate and overextended health budget in developing countries (Delisle, Agueh, & Fayomi, 2011).

Within peer-reviewed literature, the terminology of double burden of malnutrition varies among authors. Authors have addressed the "double burden of malnutrition" at the individual

level (Gartner et al., 2014), household level (Dieffenbach & Stein, 2012; Lee, Houser, Must, de Fulladolsa, & Bermudez, 2012; Oddo et al., 2012), and population or country level (Le Nguyen et al., 2011; Rojroongwasinkul et al., 2013; Sandjaja et al., 2013; Manyanga, El-Sayed, Doku, & Randall, 2014). Double burden occurring within the household level indicated by high prevalence of child stunting and overweight/obese mother (SCOWT) has been deemed largely preventable due to mothers and children sharing the same socio-economic environment. Moreover, maternal parenting has been portrayed as a key factor to prevent SCOWT, as mothers often control the purchase and distribution of food in the household (Rosenkranz & Dzewaltowski, 2008). A study in households experiencing double burden of malnutrition in Indonesia showed that the role of women's empowerment and decision-making process was influential for reduction of nutrition and health inequality (Vaezghasemi et el., 2014). In this scenario, the role of the mother was pivotal, but also based on an assumption that households were not food insecure, limiting access to adequate food, let alone foods enabling a healthy diet.

Evidence shows that food insecurity is one of the risk factors for child stunting, but there is currently little evidence that food insecurity is risk factor for double burden of malnutrition (Restrepo-Méndez et al., 2014; Lee et al., 2012). A cross sectional study in rural Indonesia demonstrated that higher intakes of animal products was protective against SCOWT (Sekiyama et al., 2015), but the lack of animal protein intake was more indicative of dietary diversity than a valid indicator for food insecurity. A Guatemalan study revealed that households suffering from SCOWT had the highest per capita consumption in the 3rd quintile (Lee et al., 2012) and not in the lowest quintile, as an indication of limited food access. Hence, these SCOWT households are believed to have some degree of food security that enables them to be placed in the middle quintile of per capita food consumption. This feature was opposite from the households with

child stunting alone, where the per capita food consumption was in the 1st quintile (Lee et al., 2012). Such evidence led researchers to hypothesize that food insecurity was not associated with double burden of malnutrition (Lee et al., 2012) as it was strongly associated with child stunting (Restrepo-Méndez et al., 2014; Lee et al., 2012). In this study, we aimed to determine the relationship between household food insecurity as measured by the categorization of the household food insecurity access scale (HFIAS) and double burden of malnutrition as indicated by household stunted child and overweight/obese mother (SCOWT).

Methods

This cross-sectional study about food security and double burden of malnutrition was undertaken with individual assessments administered by trained interviewers in April to May 2015. Urban households were selected through a systematic cluster sampling methods from 14 integrated health posts *(posyandu)* in Surabaya, Indonesia (Figure 1).

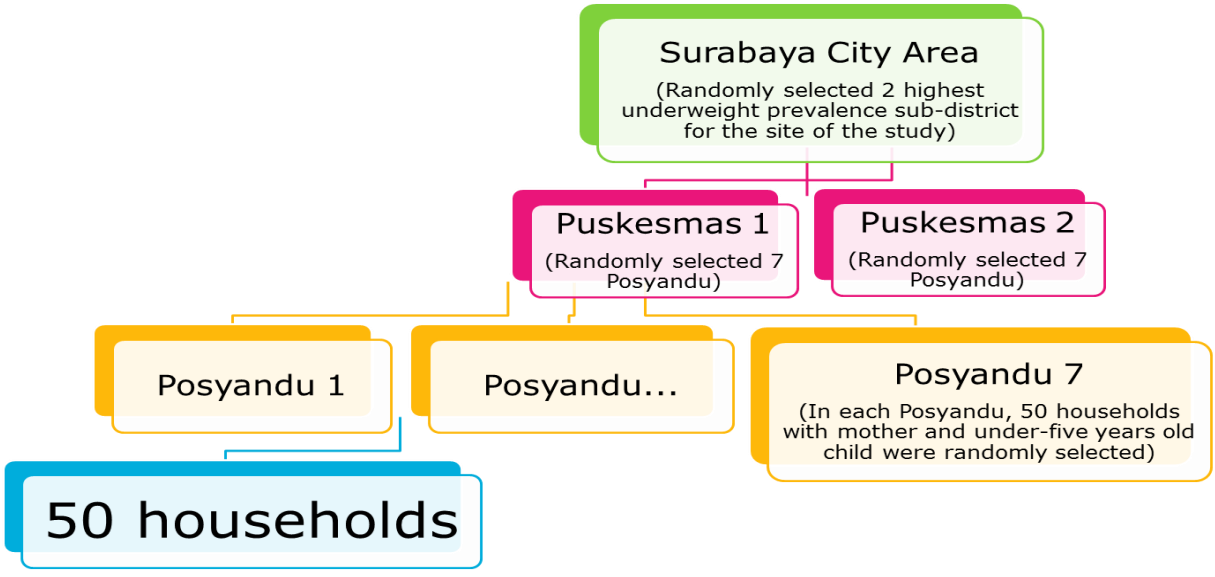

Figure 4.1 Systematic cluster sampling methods from 14 different integrated health posts *(posyandu)* involving total of 700 urban households in Surabaya, Indonesia.

Access to existing secondary data of a monthly child growth monitoring system was given upon approval from the District Health Department in Surabaya, Indonesia. Based on these data, we determined a list of sub-districts in Surabaya City that had high prevalence of child underweight relative to national prevalence. Sub-districts with prevalence of child underweight of more than 15% were randomly selected for survey location. In each sub-district, randomization was performed to select the community health post, so-called *"posyandu"* (Mahmudiono, 2007) as the point of anthropometric measurement. Mothers who came for a monthly child health monitoring in *"posyandu"* were asked to participate in the study and provide informed consent. Inclusion criteria were: informed consent obtained, mother reported no physical disability to walk for minimum 10 minutes continuously, and mother had a child under 5 years old.

This was a fully powered study with 99% confidence level, 5% margin of error and population estimate of under-five years old children population in Surabaya City using 2013 data (N=181,263 children) (Badan Pusat Statistik Kota Surabaya [BPS Surabaya], 2013). Assuming 50% response distribution, minimal sample needed were 662 participants. Accounting for 5% non-response rate, we surveyed 700 households with mothers and at least one child between 2 and 5 years of age. Excluding cases with missing data or extreme values (Mei & Grummer-Sratwn, 2007), 685 households were analyzed.

A survey questionnaire was administered by trained research assistant in a one-on-one interview to mother of under five year old child in their house. The interview lasted for approximately 30 minutes. The questionnaire consisted of: demographic characteristics; socio economic status (based on Indonesian Basic Health Research Questionnaire/IBHRQ); food security, using the Household Food Insecurity Access Scale (HFIAS). All questionnaires were translated in Indonesian language and survey was delivered in a one-on-one interview using

Indonesian language (Bahasa). The HFIAS score ranged from absolute food security (score = 0) to severely insecure (maximum score=27). There were four categories of food insecurity status, according to the HFIAS guidelines (Coates, Swindale, & Bilinsky, 2007): “food secure”, “mildly food insecure”, “moderately food insecure” and “severely food insecure”. Reliability analysis was performed to test the internal consistency for the 9 items HFIAS questions.

Anthropometric measurements were conducted in *"posyandu"* setting by trained research assistant, including maternal weight, maternal height, child weight, and child height/length. Child height and weight were assessed (in light clothing) using a stadiometer SECA 213 (Seca GmbH & Co.Kg, Germany) and Camry EB6571 digital scale (Guangdong, China) to 0.01 kg for weight. Maternal weight and height were assessed (in light clothing) using Camry EB6571 digital scale and height rod (stadiometer SECA 213). Mothers were weighed and measured for height to determine obesity status. Child age in months was assessed from 2 sources, 1st was from mother's answered when interviewed and second was based on the date of birth listed on the health monitoring card/registry in *"posyandu"*. If the month was not matched, we used the *"posyandu"* registry as the primary source. Child stunting was defined as z-score less than -2 standard deviations (SD) from the average height for age z-score (HAZ) based on the Multiple Growth Reference Standard (MGRS) from the WHO in 2006 (World Health Organization [WHO], 2006). Quality management of HAZ data was applied by using WHO recommended cut-off for extreme values (Mei & Grummer-Sratwn, 2007). Children with HAZ of more than ± 6 were excluded from the analysis. Maternal BMI was calculated based on the BMI formula with overweight defined as BMI of 25kg/m2 to 29.99kg/m2 and obese as BMI of more than 30 kg/m2. Finally, double burden of malnutrition as measured by SCOWT was defined by combined occurrence of child stunting and maternal overweight/obesity within one household.

We conducted reliability analysis to test the internal consistency for the 9 questions of the HFIAS for 685 households. We used a conventional Cronbach's alpha of 0.65 to 0.80 to indicate that the questions in the HFIAS had an acceptable internal consistency (Vaske, 2008). We obtained Cronbach's alpha of 0.831, which indicated that the questions had sufficient internal consistency. We performed principle component analysis (PCA) to derive the "wealth index" (Cronbach's alpha=0.328) from 5 items of possession/access to 5 facilities adapted from IBHRQ, namely, electricity, radio/tape recorder, TV, telephone/hand phone, and refrigerator. Descriptive statistics were used for illustrating household characteristics and for determining the prevalence of the outcome variables. Potential predictors of child stunting, maternal overweight/obesity and SCOWT were determined by univariate logistic regression, including maternal literacy, maternal education, family type, number of children and number of children under age five years in the household, maternal occupation, paternal occupation, household monthly income, household food expenditure, paternal smoking status, wealth index, and food insecurity status. Prior to the analysis, tests of multicollinearity were performed for all independent variables listed above. We employed the variance inflation factor (VIF) of less than 2.5 for all our analyses to detect that multicollinearity was not a problem (O'Brien, 2007; Liao & Valliant, 2012; Allison, 2012). Chi-Squared test was performed to analyze differences between variables. Multiple logistic regressions were performed to control for confounding factors using backward stepwise selection with significance level of 0.2 used for removal from the model. All data analysis was performed in IBM SPSS Statistics 22.

This study was approved by The Institutional Review Board (IRB) Kansas State University, USA (reference or proposal number: 7646). In addition, this study was approved by the Surabaya City Review Board (Bakesbangpol No: 1366/LIT/2015) Indonesia. We explained

the study objectives and obtained written informed consent during monthly integrated health post meeting *(posyandu)*, where mother bring their under-five year's old children for growth monitoring. Participants were free to withdraw from the study at any time without any consequences.

Results

The selected characteristics of samples in this study were presented in Table 1. The majority of mothers were housewives without a maid, literate in Bahasa Indonesia, and had enrolled or finished primary school (41%). When we employed the Chi-Squared test based on food insecurity status of the households, significant differences in the household's characteristics emerged for maternal literacy (P=0.012) and maternal education (P<0.001), but not with maternal occupation (P=0.692). Most of the households were nuclear families, having 1-2 children and having only 1 under-five years old child living in the household. Almost all fathers were working, and nearly 70% of them were smokers.

Table 4.1 Characteristics of households in Surabaya, Indonesia on their food security status (n 685)

Variable	Food security		Mild insecurity		Moderate insecurity		Severe insecurity	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Maternal literacy* (P=0.012)								
Illiterate	17	2.5	11	1.6	9	1.3	20	2.9
Partially literate	32	4.7	20	2.9	19	2.8	23	3.4
Literate	239	34.9	126	18.4	77	11.2	92	13.4
Maternal education*** (P<0.001)								
No schooling	9	1.3	10	1.5	4	0.6	15	2.2
Primary	79	11.5	73	10.7	50	7.3	80	11.7
Secondary	62	9.1	32	4.7	27	3.9	17	2.5
High-school	107	15.6	36	5.3	21	3.1	23	3.4
College	31	4.5	6	0.9	3	0.4	0	0
Family type (P=0.604)								
Nuclear family	180	26.3	98	14.3	63	9.2	80	11.7
Extended family	108	15.8	59	8.6	42	6.1	55	8.0
Number of child at home (P=0.453)								
1-2 children	211	30.8	103	15.0	79	11.5	89	13.0
3-4 children	72	10.5	49	7.2	24	3.5	42	6.1

>4 children	5	0.7	5	0.7	2	0.3	4	0.6
Number of under 5 years old children in the household* (*P*=0.046)								
1 child	260	38.0	141	20.6	91	13.3	125	18.2
2 children	28	4.1	13	1.9	14	2.0	10	1.5
3 children	0	0	3	0.4	0	0	3	0.4
Maternal occupation (*P*=0.692)								
Housewife without maid	216	31.5	118	17.2	86	12.6	100	14.6
Housewife with maid	10	1.5	5	0.7	4	0.6	7	1.0
Government officer (PNS/BUMN/Army/Police)	5	0.7	2	0.3	0	0	2	0.3
Private sector	23	3.4	7	1.0	4	0.6	8	1.2
Trade and entrepreneur	25	3.6	11	1.6	5	0.7	10	1.5
Labor/miscellaneous services	9	1.3	14	2.1	6	0.8	8	1.1
Paternal occupation*** (*P*<0.001)								
Househusband	0	0	0	0	0	0	1	0.1
Government officer (PNS/BUMN/Army/Police)	56	8.2	4	0.6	2	0.3	1	0.1
Private sector	93	13.6	49	7.2	24	3.5	26	3.8
Trade and entrepreneur	44	6.5	26	3.8	27	4.0	13	1.9
Labor	69	10.1	58	8.5	30	4.4	69	10.1
Other	25	3.7	19	2.7	22	3.2	24	3.5
Household's monthly income*** (*P*<0.001)								
< Rp. 500,000 ($50)	3	0.4	3	0.4	3	0.4	2	0.3
Rp. 500,000 – 1,000,000 ($50 – 100)	21	3.1	29	4.2	28	4.1	36	5.3
> Rp. 1,000,000 – 1,500,000 ($100 – 150)	66	9.6	60	8.8	44	6.4	48	7.0
> Rp. 1500,000 – 2,000,000 ($150 – 200)	39	5.7	28	4.1	12	1.8	21	3.1
> Rp. 2,000,000 – 2,500,000 ($200 – 250)	28	4.1	8	1.2	11	1.6	16	2.3
> Rp. 2,500,000 – 3,000,000 ($250 – 300)	55	8.0	18	2.6	3	0.4	4	0.6
> Rp. 3,000,000 ($300)	76	11.1	11	1.6	4	0.6	8	1.1
Household's monthly food expenditure** (*P*=0.002)								
< Rp. 500,000 ($50)	11	1.6	17	2.5	7	1.0	17	2.5
Rp. 500,000 – 1,000,000 ($50 – 100)	125	18.2	73	10.7	56	8.2	57	8.3
> Rp. 1,000,000 – 1,500,000 ($100 – 150)	90	13.1	48	7.0	35	5.1	47	6.9
> Rp. 1500,000 – 2,000,000 ($150 – 200)	23	3.4	10	1.5	3	0.4	9	1.3
> Rp. 2,000,000 – 2,500,000 ($200 – 250)	17	2.5	4	0.6	3	0.4	5	0.7
> Rp. 2,500,000 ($250)	22	3.2	5	0.7	1	0.1	0	0
Paternal smoking status* (*P*=0.045)								
Not smoking	102	15.0	42	6.2	25	3.7	35	5.1
Smoking	184	27.0	114	16.7	80	11.7	100	14.7

Note. P obtained with Chi-Squared tests. Values were significantly different from those of food-secure households: **P*<0.05, ***P*<0.01, ****P*<0.001.

Chi-squared tests also showed significant differences in the household's food insecurity status for number of under-five children in the household (*P*=0.046), paternal occupation (*P*<0.001), monthly income (*P*<0.001), monthly food expenditure (*P*=0.002) and paternal smoking status (*P*=0.045).

ANOVA test in Table 3 showed that compared to the food secure households, households with some level of food insecurity were significantly different in terms of monthly income,

monthly food expenditure and wealth index. However, no significant difference was found among households across food insecurity status in father's monthly cigarettes expenses.

Table 4.2 Mean and SE of family size, total income, food expenditure, tobacco expenditure and communication expenditure of household in Surabaya, Indonesia based on food security status (n=685)

Variable (all expenses was in IDR 1,000/month)	Food security		Mild insecurity		Moderate insecurity		Severe insecurity	
	Mean	SE	*Mean*	SE	*Mean*	SE	*Mean*	SE
Household's monthly income	2,664	117	1,785*	110	1,663*	93	1,583*	86
Household's monthly food expenditure	1,140	37	995**	44	1,075**	53	1,013**	43
Father's monthly cigarettes expenses	348	14	292	18	338	25	349	30
Wealth index	0.47	0.11	-0.36*	0.14	-0.09*	0.83	-0.50*	0.12

Note. P obtained with ANOVA tests. Mean values were significantly different from those of food-secure households: **P*<0.001, ***P*<0.05

Table 4 revealed that possession of electricity did not differ between households with different food insecurity status. However, there were significant differences among households with different food insecurity status in the possession of radio/tape recorder (*P*<0.001), TV (*P*=0.013), Telephone/Hand phone (*P*<0.001), and Fridge (*P*<0.001).

Table 4.3 Food security status in relation to possession of different facilities of household in Surabaya, Indonesia (n=685)

Facilities available in the households	Food security		Mild insecurity		Moderate insecurity		Severe insecurity	
	n	%	*n*	%	*n*	%	*n*	%
Electricity (*P*=0.711)	285	41.9	156	22.8	105	15.3	135	19.7
Radio/Tape recorder* (*P*<0.001)	118	17.2	36	5.3	34	5.0	31	4.5
Television** (*P*=0.013)	285	41.6	152	22.2	105	15.3	127	18.5
Telephone/Hand phone* (*P*<0.001)	282	41.2	149	21.8	100	14.6	114	16.6
Refrigerator* (*P*<0.001)	203	29.6	68	9.9	51	7.4	48	7.0

Note. P obtained with X^2 tests. Values were significantly different from those of food-secure households: **P*<0.001, ***P*<0.05

The mean score of the HFIAS was 4.85 (SD=5.6), with range of 0 to 24. Table 2 shows the affirmative responses and mean score of the HFIAS items.

Table 4.4 Distribution of affirmative responses and mean scores to items on the Household Food Insecurity Access Scale (HFIAS): households (n=685) in urban Surabaya, Indonesia, May 2015

HFIAS questions ***(Due to lack of food or limited resources to obtain food, in the past four weeks did you or any household member…)***	**Affirmative responses**		**Mean score**	
	n	**%**	**Mean**	**SD**
Q1: *Worry about food*	353	51.5	1.03	1.163
Q2: *Unable to eat preferred foods*	325	47.4	0.89	1.094
Q3: *Eat just a few kinds of foods*	249	36.4	0.71	1.052
Q4: *Eat foods they really do not want to eat*	243	35.5	0.70	1.065
Q5: *Eat smaller meals in a day*	199	29.1	0.56	0.986
Q6: *Eat fewer meals in a day*	156	22.8	0.47	0.940
Q7: *No food of any kind in the household*	79	11.5	0.18	0.542
Q8: *Go to sleep hungry*	104	15.2	0.25	0.668
Q9: *Go a whole day and night without eating*	22	3.2	0.06	0.342

Note. HFIAS=Household Food Insecurity Access Scale.

More than half of the participants were worried about food, and nearly half of households: had concern that they were unable to eat preferred foods (47.4%); ate few kinds of foods (36.4%); and ate foods they really did not want to eat (35.5%). Approximately 3.2% of the participants stated that in the last four weeks they or any household member went a whole day and night without eating anything. The majority of households never experienced complete lack of food of any kind in the household for the past month (88.5%). Based on the HFIAS guidelines, many households were categorized as food secure (42%), but there were relatively high proportions of mild (22.9%), moderate (15.3%) and severe (19.7%) food insecurity.

Results revealed that the prevalence of child stunting was 36.5%, maternal overweight/obesity was 58.8%, and the double burden of malnutrition categorized as SCOWT was 21.2%. As seen in Table 5, the results of the univariate logistic regression showed that maternal height was protective against child stunting (OR=0.883; 95%CI=0.854-0.914) and

SCOWT (OR=0.893; 95%CI=0.895-0.929) but not protective for maternal overweight/obesity (OR=0.976; 95%CI=0.949-1.005). Maternal education also showed significant association with stunting using mother with low education level as reference, having educated mother and highly educated mother lessen the likelihood of child stunting. Only educated mothers showed a protective effect on SCOWT (OR=0.514; 95%CI=0.326-0.809) but not highly educated mothers. Compared to having 1-2 children, having 3-4 children increased the likelihood of child stunting (OR=1.418; 95%CI=1.004-2.005), maternal overweight/obesity (OR=1.932; 95%CI=1.347-2.771), and SCOWT (OR=1.843; 95%CI=1.245-2.729). Mothers who worked in the private sector had less likelihood of having their child being stunted (OR=0.444; 95%CI=0.208-0.946) when compared to mothers with occupational status as a housewife without maid.

Table 4.5 Odds ratios (ORs) for child stunting, maternal overweight/obesity, and SCOWT using univariate and multiple logistic regressions

Variable	Child stunting				Maternal overweight/obesity				SCOWT			
	Crude OR	**95% CI**	***Adjusted OR***	**95% CI**	***Crude OR***	**95% CI**	***Adjusted OR***	**95% CI**	***Crude OR***	**95% CI**	***Adjusted OR***	**95% CI**
Maternal height	0.883*	(0.854-0.914)	0.900*	(0.867-0.933)	0.976	(0.949-1.005)			0.893*	(0.859-0.929)	0.876*	(0.823-0.933)
Maternal literacy												
Illiterate	Ref.				Ref.				Ref.			
Partially literate	1.005	(0.519-1.946)			0.999	(0.501-1.991)			1.303	(0.617-2.752)		
Literate	0.611	(0.352-1.061)			0.720	(0.407-1.273)			0.734	(0.387-1.392)		
Maternal education												
Low educated	Ref.		Ref.		Ref.				Ref.			
Educated	0.475*	(0.328-0.688)	0.652***	(0.426-0.997)	0.815	(0.581-1.145)			0.514**	(0.326-0.809)		
Highly educated	0.338**	(0.152-0.749)	1.038	(0.379-2.839)	0.795	(0.415-1.525)			0.654	(0.281-1.520)		
Family type												
Nuclear family	Ref.				Ref.				Ref.			
Extended family	1.091	(0.792-1.501)			1.001	(0.732-1.369)			1.009	(0.692-1.471)		
Number of child at home												
1-2 children	Ref.				Ref.		Ref.		Ref.			
3-4 children	1.418***	(1.004-2.005)			1.932*	(1.347-2.771)	1.908**	(1.320-2.758)	1.843**	(1.245-2.729)		
>4 children	1.508	(0.552-4.122)			0.826	(0.305-2.236)	0.866	(0.315-2.378)	1.513	(0.477-4.804)		
Number of under 5 years old children in the household												
1 child	Ref.				Ref.				Ref.			
2 children	0.947	(0.555-1.616)			1.135	(0.671-1.918)			1.135	(0.617-2.086)		
3 children	0.865	(0.078-9.593)			1.418	(0.128-15.73)			1.891	(0.170-21.02)		
Maternal occupation												
Housewife without maid	Ref.				Ref.				Ref.			
Housewife with maid	1.626	(0.325-8.136)			3.696	(0.429-31.86)			3.643	(0.725-18.29)		
Private sector	0.444***	(0.208-0.946)			1.201	(0.629-2.293)			0.607	(0.250-1.477)		
Trade and entrepreneur	0.813	(0.442-1.494)			0.900	(0.505-1.604)			0.781	(0.369-1.652)		
Labor/miscellaneous services	0.444	(0.122-1.609)			2.464	(0.973-6.237)			0.767	(0.256-2.300)		
Paternal occupation												
Government officer	Ref.		Ref.		Ref.				Ref.			
Private sector	5.273**	(2.013-13.81)	3.091***	(1.026-9.311)	1.051	(0.594-1.861)			3.174***	(1.080-9.331)		

Trade and entrepreneur	7.909*	(2.942-21.26)	4.480***	(1.438-13.96)	1.119	(0.601-2.084)			4.288***	(1.418-12.96)		
Labor	8.100*	(3.112-21.08)	3.752***	(1.222-11.521)	1.514	(0.852-2.689)			4.367**	(1.504-12.68)		
Other	11.07*	(4.047-30.29)	4.656***	(1.421-15.257)	1.130	(0.587-2.172)			6.045**	(1.983-18.43)		
Household's monthly income												
< $50	Ref.				Ref.				Ref.			
$50 – 100	1.871	(0.471-7.423)			0.694	(0.174-2.762)			1.607	(0.328-7.864)		
> $100 – 150	2.022	(0.522-7.827)			0.523	(0.135-2.027)			1.339	(0.280-6.401)		
> $150 – 200	1.634	(0.408-6.542)			0.458	(0.115-1.829)			1.196	(0.240-5.960)		
> $200 – 250	1.754	(0.424-7.256)			0.652	(0.157-2.705)			1.170	(0.225-6.087)		
> $250 – 300	1.358	(0.333-5.539)			0.414	(0.102-1.677)			1.402	(0.278-7.057)		
> $300	0.520	(0.124-2.176)			0.500	(0.125-1.999)			0.511	(0.097-2.705)		
Household monthly food expenditure												
< $50	Ref.				Ref.		Ref.		Ref.			
$50 – 100	1.121	(0.610-2.061)			1.876***	(1.038-3.393)	1.757	(0.966-3.196)	2.145	(0.879-5.236)		
> $100 – 150	0.973	(0.519-1.824)			2.250**	(1.220-4.153)	2.052***	(1.105-3.812)	2.314	(0.935-5.728)		
> $150 – 200	0.868	(0.376-2.008)			1.725	(0.771-3.863)	1.501	(0.663-3.398)	2.190	(0.727-6.603)		
> $200 – 250	0.782	(0.297-2.058)			0.890	(0.355-2.232)	0.851	(0.336-2.154)	1.597	(0.442-5.775)		
> $250	0.695	(0.231-2.092)			1.146	(0.415-3.167)	0.928	(0.330-2.614)	2.396	(0.643-8.934)		
Paternal smoking status												
Not smoking	Ref.				Ref.				Ref.			
Smoking	1.111	(0.789-1.566)			0.962	(0.689-1.342)			1.046	(0.699-1.567)		
Wealth index	0.826**	(0.728-0.937)			0.997	(0.913-1.088)			0.908	(0.816-1.011)		
Food insecurity												
Food secure	Ref.		Ref.		Ref.				Ref.		Ref.	
Mildly food insecure	1.987**	(1.318-2.996)	1.468	(0.938-2.297)	1.329	(0.893-1.978)			3.089*	(1.889-5.049)	3.707**	(1.614-8.518)
Moderately food insecure	1.755***	(1.096-2.811)	1.295	(0.772-2.173)	1.300	(0.823-2.054)			3.028*	(1.750-5.240)	4.541**	(1.889-10.92)
Severely food insecure	2.621*	(1.711-4.016)	1.908**	(1.175-3.097)	1.164	(0.769-1.761)			2.246**	(1.320-3.820)	3.151***	(1.321-7.515)

Note. 685 among 700 households with non-missing variables were used for the multivariate logistic regression analysis. For multivariate logistic regression, all variables listed in Table 1 and food insecurity status based on the Household Food Security Access Scale (HFIAS) category were used and selected by backward stepwise selection with significance level of 0.2 for removal from the model. Test of multicollinearity between independent variables used in the multivariate logistic regression showed the Variance Inflation Factor (VIF) from 1.000 to 1.372 that indicates no sign of multicollinearity. All the selected variables were used for calculating adjusted odds ratios (adjusted ORs). Values were significantly different from those of food-secure households: * $P<0.001$, ** $P<0.01$, *** $P<0.05$

While in paternal occupation, the risk of child stunting was increased in the households where the father was working in the private sector (OR=5.273; 95%CI=2.013-13.81), trade and entrepreneur (OR=7.909; 95%CI=2.942-21.26), labor (OR=8.100; 95%CI=3.112-21.08), or others (OR=11.07; 95%CI=4.047-30.29) as compared to fathers who worked as government officer (including army, police). Similarly, using paternal occupation as government officers, having a father who worked in the private sector (OR=3.174; 95%CI=1.080-9.331), trade and entrepreneur (OR=4.288; 95%CI=1.418-12.96), labor (OR=4.367; 95%CI=1.504-12.68), or others (OR=6.045; 95%CI=1.983-18.43) were also increasing the risk of SCOWT in the household. Household monthly income was not significantly correlated with either child stunting, maternal overweight/obesity or SCOWT. While household monthly food expenditure of $100-150 were significantly increasing the risk of maternal overweight/obesity when compared to household with expenses less than $50 per month (OR=2.250; 95%CI=1.220-4.153). Wealth index was significantly correlated with child stunting (OR=0.826; 95%CI=0.728-0.937) but not related to maternal overweight/obesity (OR=0.997; 95%CI=0.913-1.088) and also not related with SCOWT (OR=0.908; 95%CI=0.816-1.011). Last, food insecurity status was significantly correlated with child stunting and SCOWT but not significantly correlated with maternal overweight/obesity. Using food secure households as reference, increased likelihood of child stunting was observed in households with mildly food insecure (OR=1.987; 95%CI=1.318-2.996), moderately food insecure (OR=1.755; 95%CI=1.096-2.811) and severely food insecure (OR=2.621; 95%CI=1.711-4.016). Likewise, similar patterns were observed in relation to SCOWT where the risk of SCOWT was increased in households with mildly food insecure (OR=3.089; 95%CI=1.889-5.049), moderately food insecure (OR=3.028; 95%CI=1.750-5.240) and severely food insecure (OR=2.246; 95%CI=1.320-3.820) relatively compared to food secure

households. Figure 2 illustrates that the household with stunted children and SCOWT have significantly higher HFIAS score, compared to households without stunted children or household that are not SCOWT, respectively

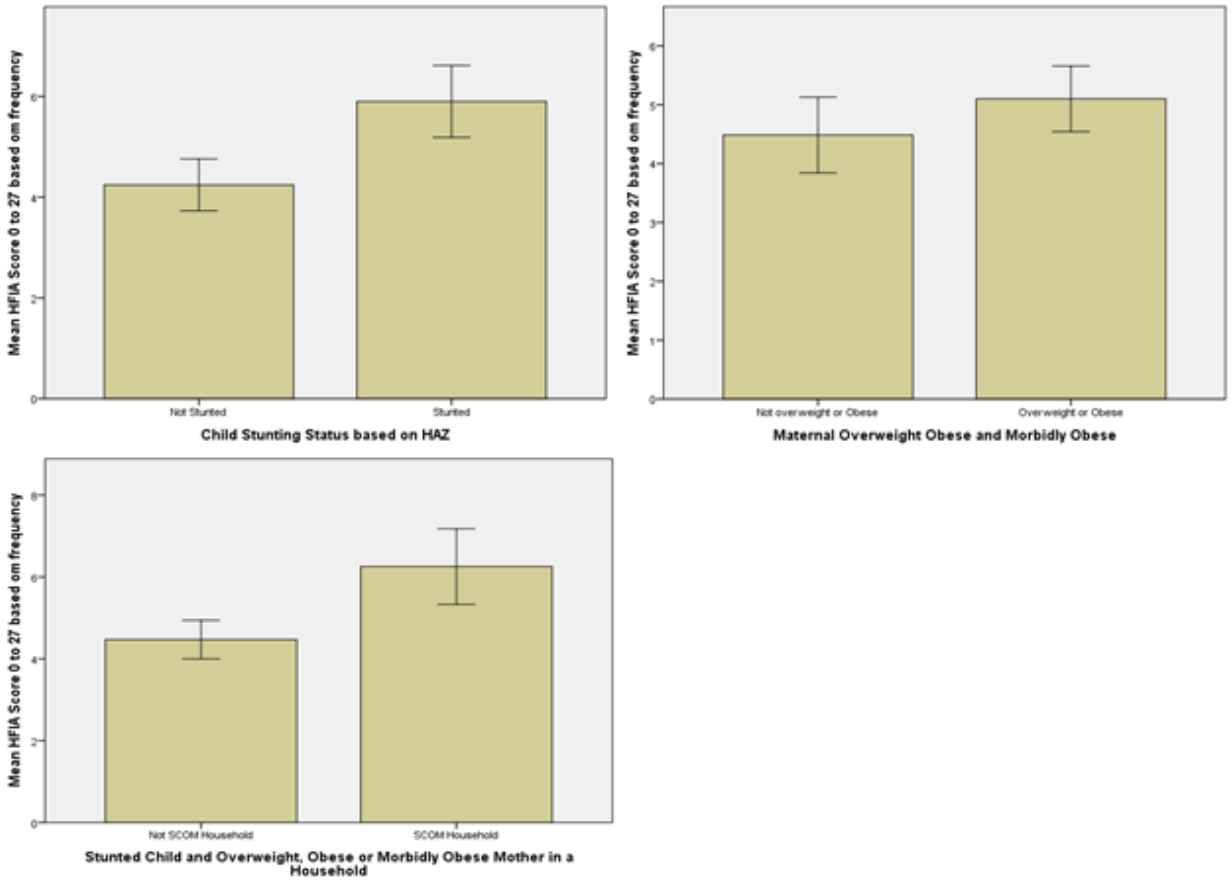

Figure 4.2 Household Food Insecurity Access Scale (HFIAS) score in relation to child stunting, maternal overweight/obesity and SCOWT status among urban households in Surabaya, Indonesia, in May 2015.

Multivariate analysis

The backward stepwise multiple logistic regression model showed that maternal height, maternal education, paternal occupation and food insecurity status that were significantly associated with child stunting. Factors that were significantly associated with reduced likelihood

of child stunting were: maternal height (adjusted OR [aOR]=0.900; 95%CI=0.867-0.933), educated mother (aOR=0.652; 95%CI=0.426-0.997). Paternal occupation was significantly related with increased risk of child stunting. Compared to father that worked as government officer (including army and police), having father worked in private sector (aOR=3.091; 95%CI=1.026-9.311), trade & entrepreneur (aOR=4.480; 95%CI=1.438-13.860), labor (aOR=3.752; 95%CI=1.222-11.521), others work (aOR=4.656; 95%CI=1.421-15.257) increase the risk of having child stunting in the household. Compared to the food secure household, only household that was severely food insecure increased the likelihood of child stunting (aOR=1.908; 95%CI=1.175-3.097).

Having 3-4 children relative to having 1-2 children at home was associated with increased likelihood of maternal overweight/obesity (aOR=1.908; 95%CI=1.320-2.758). Similarly, spending >$100-150 per month on food was associated with increased likelihood of maternal overweight/obesity (aOR=2.052; 95%CI=1.105-3.812) compared to expending less than $50 per month.

The backward stepwise multiple logistic regression model of SCOWT revealed that maternal height and food insecurity status served as significant predictors. Increased maternal height reduced the likelihood of SCOWT (aOR=0.876; 95%CI=0.823-0.933). While for food insecurity status, compared to food-secure households, mild food insecurity (aOR=3.707; 95%CI=1.614-8.518), moderate food insecurity (aOR=4.541; 95%CI=1.889-10.92), and severe food insecure (aOR=3.151; 95%CI=1.321-7.515) increased the likelihood of households experiencing SCOWT.

Discussion

The objective of our study was to analyze the relationship between household food insecurity as measured by the household food insecurity access scale (HFIAS) category and double burden of malnutrition as indicated by household stunted child and overweight/obese mother (SCOWT). These results support the hypothesis that double burden of malnutrition is robustly related to food insecurity, and categorization of the HFIAS as a measure of food insecurity is a predictor of SCOWT. To the best our knowledge, this is the first published study of the application of this scale within an urban setting of Indonesia.

Our study revealed that the prevalence of double burden in mother-child pair was 21.2% whereas the prevalence of child stunting was 36.5%, and maternal overweight/obesity was 58.8%. This prevalence was higher than previous study in rural Indonesian setting that found 11% of the samples were consisted of maternal overweight and stunted child coexisted within the same household (Oddo et al., 2012). Our results confirmed a previous study that posited the prevalence of double burden of malnutrition was higher in urban area compared to rural area (Vaesghazemi et al., 2014). Studies in Nairobi, Kenya showed that the obesogenic environment in urban setting was characterized by reliance on energy-dense street food and arguably responsible for the rise of overweight/obesity in this population (Kimani-Murage, et al., 2014; Kimani-Murage, et al., 2015). However, a more recent study in a rural setting of Indonesia reported higher percentage of double burden, as measured in the coexistence of maternal overweight and child stunting in one household (Sekiyama et al., 2015). A staggering 30.6% of double burden in mother-child pairs reported in that study (Sekiyama et al., 2015) was partly explained by different cut-off point used for determining maternal overweight. Those authors used the BMI≥23kg/m2 to identify overweight mothers while we implemented a more standard

approach by using BMI≥25kg/m2 to determine maternal overweight. Furthermore, in an Indonesian setting, regional differences was argued to be attributable to the discrepancy in the prevalence of double burden observed in mother-child pairs (Sekiyama et al., 2015; Vaesghazemi et al. 2014). Nevertheless, evidence from studies in Indonesia consistently has shown a prevalent problem of double burden of malnutrition in the form of stunted child and overweight/obese mother pairs across settings and geographical locations.

Although evidence showing a relationship between food insecurity and child stunting is abundant, there is a scarcity of evidence relating food insecurity with double burden of malnutrition. In this study, we found that food insecurity was significantly associated with double burden of malnutrition, as observed in the coexistence of stunted child and overweight/obese mother within the same household. Most of the households involved in this study were experiencing some form of food insecurity (58%). In a univariate logistic regression, using food secure household as reference we revealed that having mildly food insecure household increased the risk of double burden by more than 3 times, having moderately food insecure household increased the risk by more than 3 times, and having severely food insecure household increased the risk by more than 2 times. This association persisted in the multivariate logistic model, in fact the likelihood was even stronger. Compared to the food secure household, having mildly food insecure household the risk of double burden was more than 3.7 times higher, having moderately food insecure household increased the risk by 4.5 times and having severely food insecure household increased the risk by more than 3 times.

Our study showed that food insecurity was more robust to predict double burden of malnutrition indicated by SCOWT than in predicting child stunting alone. As seen in Table 5, even though 4 categories of food insecurity was significantly correlated to both SCOWT and

child stunting in the univariate logistic regression, only severely food insecure households remained associated with child stunting in the multivariate model. Whereas, any form of food insecurity remained significantly associated with SCOWT in the multivariate logistic regression model. We are not aware of any published studies with which to compare our findings that relate food insecurity and double burden of malnutrition. A study in Indonesia highlighted an association between living in households with a higher SES and increased risk of double burden of malnutrition (Vaesghazemi et al. 2014). Also, a study in Guatemala showed an association between per capita household consumption and SCOWT (Lee et al., 2012). Both of these studies revealed that double burden of malnutrition was related with some form of household access to food, indicated by higher SES and per capita consumption. The fact that our analysis using levels of food insecurity status showed steady association with SCOWT and not with child stunting aligns with this argument. Mildly food insecure and moderately food insecure households were significantly associated with increased risk of SCOWT, and not significantly correlated with child stunting. This was an indication that the decreasing quality and choice of food as building block for mildly and moderately food insecure household was sensitive enough to predict SCOWT.

In broader terms, we believe that with minor food insecurity, households may compromise their diet towards cheaper food that is mostly high in energy. Hence, we argue that double burden of malnutrition exists because the child was stunted due to insufficient availability and intake of growth promoting and nutrient-dense foods whereas mother was supplied with an abundance of energy-dense foods that promote weight gain. In countries experiencing nutrition transition, much of the energy dense food are not nutritiously dense and hence provide a limited support for the children's growth (Dieffenbach & Stein, 2012). Households that were not facing

mild and moderate food insecurity might be able to purchase foods that were more expensive but were more nutrient dense, such as animal-based foods. Animal-based foods are a good source of growth-promoting nutrients, such as protein and amino acids (Uauy et al., 2015). A study in rural Indonesia showed that a dietary pattern of "high-animal products" was associated with decreased likelihood of SCOWT through a strong inverse correlation with child stunting (Sekiyama et al., 2015).

The present study findings also add evidence regarding the relationship between maternal height/stature and double burden of malnutrition. Our multivariate analysis showed that increased maternal height decreased the likelihood of double burden of malnutrition as measured by SCOWT. A similar significant association, however, was seen for maternal height and child stunting alone. Hence, the observed correlation between maternal height and SCOWT might be driven by the association between maternal height and child stunting, even though the adjusted odds was slightly stronger for SCOWT. For this reason we believe that compared to food insecurity status as measured by the HFIAS category, maternal height was less robust in predicting SCOWT. Regardless, our study extended the widely reported association between maternal short statures and child stunting in developing countries such as Bangladesh (Oddo et al., 2012), Brazil (Felisbino-Mendes, Villamor, & Velasquez-Melendez, 2014; Ferreira et al., 2009), Indonesia (Oddo et al., 2012), and Mexico (Varela-Silva, Azcorra, Dickinson, Bogin, & Frisancho, 2009).

The multivariate logistic regression revealed that households with 3-4 children were more likely to have mothers who were overweight/obese, compared to households with 1-2 children. With less than one-third of mothers exclusively breastfeeding in Indonesia (Balitbangkes, 2013; Widodo, 2011), it is probable that having repeated pregnancy increases the risk for maternal

overweight/obesity. Mothers who provide their child with exclusive breastfeeding for 3 months had four times greater weight loss, compared to mothers who did not exclusively breastfed or who discontinued breastfeeding their child before 3 months (López-Olmedo et al., 2015). Household spending >US$ 100–150 on foods per month also increased the risk of maternal overweight/obesity, relatively compared to households with monthly food expenditure of less than US$ 50. Spending US$ 50–100 as well as >US$ 150 was not significantly related to maternal overweight/obesity. This indicates that spending >US$ 100–150 was the range of monthly food expenses that may contribute to maternal energy imbalance through the purchase of energy dense food. However, both variables (number of children and food expenditure) were not significantly correlated with SCOWT.

Strengths and Limitations

The strengths of our study were the relatively large sample derived from a fully powered sample size calculation, random sample, validated food insecurity instrument, and one-on-one interview by trained interviewers to complete questionnaires with the mother. In addition, compared to recent study about mother-child double burden in rural Indonesia, this study employed a conventional cut-off point for maternal overweight that was easily comparable to the body of knowledge related to household-level double burden of malnutrition.

A few limitations should be noted in this study. First, since it was a cross sectional study, causal inference for food insecurity status and double burden of malnutrition as observed in SCOWT cannot be established. An observational cohort study that examines changes in food insecurity over time would add more weight to the evidence for a positive relationship between food insecurity as measured in the HFIAS category and SCOWT. Second, although the HFIAS

was designed for cross-cultural setting, it was possible that some of the local perspective on food insecurity failed to be captured in the questions. We minimized errors by excluding extreme values according to the recommended cut-off for height-for-age Z-score by the WHO (Mei & Grummer-Sratwn, 2007). Last, our first attempt to choose the study site by restricting only for sub-districts with prevalence of child underweight of more than 15% according to government report might limit our generalization to the general population.

In conclusion, one fifth of households in the study site were found to be experiencing double burden of malnutrition in the form of stunted child and overweight/obese mother (SCOWT). The present study support the hypothesis that double burden of malnutrition is robustly related to food insecurity. Even though both maternal height and household's food insecurity status was significantly associated with double burden of malnutrition, only levels of food insecurity derived from the HFIAS instrument served as a good predictor of SCOWT in urban Indonesia.

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Chapter 5 - Comparison of Maternal Nutrition Literacy, Dietary Diversity and Food Security among Households Experiencing Nutrition Transition

Abstract

The double burden of malnutrition in the form of stunted child and overweight/obese mother (SCOWT) has been increasing in countries experiencing nutrition transition. We hypothesized that SCOWT households were dealing with a degree of food security, but lacked the ability to make healthy food choices as evidenced by poor dietary diversity. This cross-sectional study aimed to analyze differences in maternal nutrition literacy, dietary diversity and food security of four households categorized according to the nutritional status of mother-child pairs. Of the 700 mother-child pairs sampled in urban households in Surabaya, Indonesia, we found the prevalence of SCOWT households was 21.2%, the prevalence of overweight mother and normal child (OWT) households was 37.7%, while households with stunted child and normal mother pairs (SC) was 15.3%, and 25.8% of households were normal. There were significant differences in maternal nutrition literacy, dietary diversity, and PCA derived food security measures (quality of food and quantity of food). In the subsequent post-hoc analysis with Bonferroni correction, only maternal nutrition literacy and lack of food quality were distinctly different, but only in SCOWT and OWT households. Households with SCOWT pairs were viewed as a distinct entity. They were characterized as being food secure because they did not have to compromise their meals like the SC households, but were limited in foods they preferred to consume compared to the OWT

households. These findings emphasize the importance of developing behavioral strategies to enable mothers to make healthy food choices on a limited budget.

Keywords: nutrition literacy, dietary diversity, food security, nutrition transition, double burden of malnutrition, Indonesia

Introduction

Over two decades ago, Popkin postulated the growing problem of nutrition transition as part of complex interrelation to demographic and epidemiologic transition (Pokpin, 1994). In his recent publication, Popkin argued that the underlying cause for rapid nutrition transition in low and middle income countries (LMICs) is related to changes in the agricultural system, advancement of technologies and mechanization that decrease physical activity, urbanization, and tremendous growth of the modern food system (Popkin, 2015). As a result, nutrition transition is believed to be the driving force for the global epidemic of overweight and obesity (Popkin, Adair, & Ng, 2012), diabetes (Popkin, 2015), and double burden of malnutrition (Doak, Adair, Bentley, Monteiro, & Popkin, 2005).

The evidence showed that the prevalence of SCOWT was rapidly increasing especially countries experiencing nutrition transition (Doak et al., 2005). Secondary data analysis from Brazil, China, Indonesia, the United States and Vietnam revealed that households with double burden of malnutrition were more likely to occur in an urban setting, and within a high-income population (Doak et al., 2005). A recent review revealed that nearly all developing countries were facing the problem of double burden of malnutrition and that an increase in per capita income was associated with an increase in the overweight/underweight ratio (Abdullah, 2015).

Indonesia is categorized as developing country currently in the midst of a nutrition transition (Doak et al. 2005). With the fourth largest population in the world, the country is believed to be experiencing the double burden of malnutrition (Oddo et al., 2012; Sekiyama et al., 2015). A study in rural Indonesia reported that the prevalence of the double burden of malnutrition in the form of SCOWT was 11% in 2012 (Oddo et al. 2012). The prevalence reported in a different province but still in rural area in 2015 found the prevalence of SCOWT was 30.6%; however, this study used a lower cut-off point in determining maternal overweight than the conventional cut-off point of BMI $\geq 25 kg/m^2$ (Sekiyama et al., 2015).

The fact that the prevalence of double burden was rapidly increasing suggested that Indonesia is on the brink of having an uncompetitive workforce. The SCOWT households will not only contribute to the lack competitiveness due to the disability of overweight/obese mother that likely to have further health impairment such as high blood pressure, diabetes, and stroke, but also from the long-term consequences of child stunting. Stunted children were shown to have poor academic performance low productivity and excessive weight gain later in life (Victora et al., 2008). Stunted children may be more susceptible to nutrition-related non-communicable diseases such as high blood pressure and diabetes (Shrimpton, 2015). Current recommendations endorsed by the United Nations Children's Fund (UNICEF) are to optimize nutrition throughout the lifecycle with emphasis on the first 1,000 days of life to improve human capital, expressed in terms of intelligence, productivity, adult height, or next-generation reproductive outcomes (United Nations Children's Fund [UNICEF], 2013). Understanding specific features of SCOWT among populations undergoing nutrition transition might illuminate ways to achieve good nutrition at this critical time in children's lives.

Households with the double burden of malnutrition in the form of coexistence of underweight and overweight individuals in the same house were characterized by consumption of foods with higher fat and protein content compared to underweight and normal weight households (Doak, Adair, Bentley, Fengying, & Popkin, 2002). Though easily distinguished from the "underweight only" households, the double burden of malnutrition was relatively difficult to distinguish from the "overweight only households" (Doak et al., 2005). Some even believed that double burden of malnutrition in the form of stunted child and overweight mother (SCOWT) was just a statistical artifact, because prevalence was driven by the prevalence of maternal overweight (Dieffenbach & Stein, 2012). Moreover, a previous study failed to show significant differences in the typical diet of household with double burden of malnutrition and overweight only households (Doak et al., 2002). Others reported that that low dietary diversity is associated with increased likelihood of the double burden of malnutrition (Deleuze Ntandou Bouzitou, Fayomi, & Delisle, 2005). High consumption of animal-based foods was associated with decreased likelihood of SCOWT in rural Indonesia (Sekiyama et al., 2015) and one study in Guatemala showed that SCOWT was more prevalent among populations in the mid-quintile per capita suggesting some form of food security (Lee, Houser, Must, de Fulladolsa, & Bermudez, 2012).

We hypothesized that households with SCOWT were not necessarily food insecure, but lacked necessary behaviors for choosing healthy foods as reflected in poor dietary diversity. This lack of inability could be driven by a low level of knowledge in nutrition and not merely by limited access to healthy foods. Bandura (2004) argues that knowledge of health benefits provide necessary precondition for change. Without sufficient knowledge related to their lifestyle habits affecting their health, people have little reason to change the detrimental habits they enjoy (Bandura, 2004). One's knowledge in nutrition could be measured as nutrition literacy. Owing

the definition for health literacy, nutrition literacy could be described as the degree to which individuals have the capacity to obtain, process, and understand basic nutrition information and services needed to make appropriate nutrition-related decisions (Gibbs & Chapman-Novakofski, 2013). Nutrition literacy was measured in five domains: relationship between nutrition and health, knowledge of macronutrient, skill in food measures, numeracy and label reading, and skills in grouping food in categories (Gibbs & Chapman-Novakofski, 2013). Nutrition literacy instruments as measure for nutrition knowledge have been used across variety of age groups ranging from young adolescent (Guttersrud & Petterson, 2015) middle-aged population (Wall et al., 2014), to the elderly population (Patel et al., 2013). Nutrition literacy was showing promising content validity and reliability in study among breast cancer patient (Gibbs et al., 2015). In the tenets of SCT, Bandura argues that cognitive precondition in the form of knowledge was not enough for people to overcome the impediments to adopting new lifestyle habits and retaining them without additional self-influence and personal-efficacy (Bandura, 2004).

In this study, we aimed to analyze the differences in maternal nutrition literacy, dietary diversity and food security of four household categories based on nutritional status of maternal-child pairs. The four categories of households were normal mother-child pair (NM pair), normal mother and stunted child pair (SC pair), overweight/obese mother and normal child pair (OWT pair), and stunted child and overweight/obese mother pair (SCOWT pair).

Methods

Study population

This cross-sectional study was conducted in the second largest city in Indonesia, Surabaya, between April and May 2015. The site for the study was chosen according to the criteria of having

more than 15% prevalence of children under five years old suffering from underweight, based on the monthly child growth monitoring data in the community-driven integrated health post, or in Bahasa Indonesia known as "*Pos Pelayanan Terpadu*" or "*posyandu*" (Mahmudiono, 2007). We employed a systematic cluster sampling method involving 14 *posyandu* in an urban poor population of Surabaya, Indonesia. Recruitment for participants was based on the site where *posyandu* was held in each of the villages within the chosen sub-districts. During the *posyandu* meeting, mothers were informed about the study and invited to participate by signing written informed consent. Eligibility of participants was assessed based on the following criteria: agreement to participate by signing the informed consent, no physical disability that would prevent walking for at least 10 minutes continuously, and at least one child under 5 years old.

This cross-sectional study also served as a screening process for the behavioral intervention study targeting child stunting in households experiencing the double burden of malnutrition. To maximize detection toward households with double burden of malnutrition in the form of stunted child and overweight/obese mother (SCOWT), we used 99% statistical power with a 5% margin of error. With a general assumption of 50% response distribution, our sample size calculation showed that the minimum sample needed for the study was 662 participants. With a possible 5% non-response rate, we surveyed 700 mother-child pairs from 14 *posyandu* in the urban city of Surabaya. After cleaning data to remove extreme values and missing data, 685 samples were used in the final analysis. Even with slightly more than 2% of data excluded from the analysis, the final number of samples used was still higher than the minimum sample needed for a fully powered sample size to represent population of Surabaya.

Study protocols

This study was conducted according to the guidelines outlined in the Declaration of Helsinki and all procedures involving human subjects/patients were obtained from the Institutional Review Board (IRB) of Kansas State University, USA (reference or proposal number: 7646). In Indonesia, approval for the study was granted the Surabaya City Review Board (Bakesbangpol No: 1366/LIT/2015). Written informed consent was obtained from the mothers. Respondents were told that they could withdraw their participation in the study at any time without consequences.

Measurement

Measurement of the outcome of interest using standardized anthropometric equipment was done in *posyandu* after informed consent was obtained. The assessment of independent variables such as respondent demographics, nutrition literacy, dietary diversity, and food security was conducted in a one-on-one interview in their house. A trained interviewer delivered the structured questionnaire to the mother in Indonesian language (Bahasa) in a session that lasted approximately 30-45 minutes.

Anthropometrics

We measured the weight and height of the mother as well as the child at the site where the monthly *posyandu* meeting took place. A stadiometer SECA 213 (Seca GmbH & Co.Kg, Germany) was used to measure height and Camry EB6571 digital scale (Guangdong, China) was used in the nearest 0.01 kg to measure weight. Measurement was done twice if the reading from the first and second measurements was less than 0.5 cm difference for height and 0.05 kg for weight. The third measurement was carried out if the first and second measurements had more than the above-mentioned difference. All measurement was performed with mother and child

instructed to wear light clothing. The age of the child was determined from the health-monitoring card/registry in *posyandu*.

The World Health Organization (WHO) child growth standard 2006 was used as a reference for determining the child nutrition status based on the index of height-for-age z-score (HAZ) (World Health Organization [WHO], 2006). According to that standard, a child is categorized as stunted if the HAZ is below -2. We employed a conventional cut-off point for determining maternal overweight (BMI of 25kg/m^2 to 29.99kg/m^2) and obesity (BMI>30kg/m^2). In this study we defined the double burden of malnutrition as the coexistence of stunted child and maternal overweight/obesity in the same household (SCOWT).

Nutrition literacy assessment

We measured nutrition literacy using the content-valid nutrition literacy measures (Gibbs & Chapman-Novakofski, 2013). However, only 3 domains of nutrition literacy were used in this study due to socio-cultural differences with the original 5 domains (Gibbs & Chapman-Novakofski, 2013). The three domains were: macronutrient, household food measures, and food groups. The macronutrient domain had 6-items close-ended question modified from the original questionnaire (Cronbach's alpha=0.497). The 6 items questionnaire in the household food measure domain was adapted to reflect the common household measured used in Indonesia (Cronbach's alpha=-0.344). The food group was also adapted from the original American "MyPlate" to the Indonesian version of MyPlate known in Bahasa as "*Piring Makanku*" (Cronbach's alpha=0.564). The major difference between MyPlate and "*Piring Makanku*" was that in Indonesian "*Piring Makanku*" instead of milk we had water (Kementerian Kesehatan Republik Indonesia, 2014). As an archipelago nation, Indonesia possesses an abundance of seafood products that are high in calcium content as a substitute for milk. Another consideration for omitting milk was the growing

evidence that suggests diarrhea incidence in Indonesia was highly related to improper method of serving making and preserving milk formula from milk powder.

Dietary diversity assessment

Dietary diversity was assessed according to the Food and Agriculture Organization of the United Nations guidelines for measuring household and individual dietary diversity (Food and Agriculture Organization of the United Nations [FAO], 2010). Mothers were asked to recall food intake during the past 24 hours by answering a series of questions about each of 16 food groups. In keeping with the FAO guidelines, the 16 food groups were aggregated into 12 food groups and answers were used to create the household's dietary diversity score (HDDS). In this study we used continuous data of HDDS to reflect dietary diversity analyzing effects on the prevalence of the double burden of malnutrition measured as SCOWT. The 12 food groups listed in the final HDDS were cereals (including rice and noodles), tubers/roots, vegetables, fruits, fish (including fresh water, dried fish and seafood), meat and poultry, eggs, nuts and seeds, dairy products, spices, oils and fats, and sweets. Scores for the 12 food-group categories ranged from 0 to 12 (Cronbach's alpha=0.281).

Food security assessment

Food security was assessed using nine items from the household food insecurity access scale (HFIAS) questionnaire (Food and Nutrition Technical Assistance Project [FANTA], 2007) Originally, the score for the HFIAS ranged from 0 through 27 with a lower score indicating food security. In this study, we performed principle component analysis (PCA) to derive the measure of food security from the set of nine HFIAS questions. We used Varimax rotation with the Kaizer Normalization method for rotation of the data, and set factors with Eigen value of greater than 1.0

to be included as measures of food security. Table 3 shows the PCA results for the nine-item set of HFIAS questions.

Covariate measurement

Demographic characteristics of the households including father, mother and children under 5 years old were measured using a one-on-one interview with trained interviewer in the house of the consenting participants. Covariates measured were child's gender, mother's general literacy, mother's education, family type, number of children living at home, number of children under the age of 5 living at home, mother's occupation, father's occupation, household monthly income, and household monthly food expenditure.

Statistical analyses

We conducted a test of normality for variables under scrutiny, which were nutrition literacy score, dietary diversity score and the HFIAS score by mother-child pair categories. Because the data were not normally distributed, the statistical analysis employed to answer the research question was the Kruskal-Wallis test with post-hoc analysis with Bonferroni correction. Significance was set at $P<0.05$ for Kruskal-Wallis and $P<0.0083$ for Bonferroni correction. Descriptive statistics and Chi-square test was used to describe the demographic characteristics of the sample. The measure of food security status was derived from principle component analysis (PCA) with Varimax rotation. Statistical analysis was performed using the IBM SPSS Statistics 22 software.

Results

Description of the sample

This study found that 21.2% of the sample was experiencing double burden of malnutrition in the form of stunted child and overweight/obese mother pairs (SCOWT) living in one household.

The prevalence of overweight mother with normal child (OWT) was even higher (37.7%), while household with stunted child and normal mother pair (SC) was 15.3%. Just over one fourth (25.8%) of households had mothers with normal body mass index (BMI between 18.5 and 25.0) and normal child height-for-age z-score (HAZ between -2 to +2). As seen in Table 1, the Chi-squared test showed significant differences between nutritional status of mother-child pairs for several demographic characteristics such as maternal education (P<0.001), total number of children living in the same household (P=0.006), father's occupation (P<0.001), household income (P=0.007) and monthly food expenditure (P=0.049). However, no significant difference was observed on child's gender (P=0.065), maternal general literacy (P=0.590), family type (P=0.410), number of children under 5 years of age in the household (P=0.969), and maternal occupation (P=0.465).

The percentage of mothers that did not attend high school education was the highest among OWT pairs (24.1%) followed by SCOWT pairs (16.3%) as compared to the normal mother-child pairs (14.1%). Household with SCOWT pairs were also having higher percentage of 3 to 4 children living with them at home (7.9%) than the normal pairs (4.5%). The percentage of father's with a steady occupation as a government employee or in the private sector as a tradesman/entrepreneur was relatively higher among normal pair households (17.8%) than the SCOWT pair households (9.6%). In terms of total monthly income, the percentage of households earning more than Indonesian Rupiahs (IDR) 2,500,000 (USD 250) was higher among normal pairs (9.7%) and OWT pairs (10.2%) than SCOWT pairs (4.3%) and SC pairs (2.1%). The monthly food expenditure among households was barely statistically significant (P=0.049). The majority of respondents (77.4%) reported that the monthly food expenditure was around IDR 500,000 to IDR 1,500,000 (USD 50 to USD 150).

Table 5.1 Sample demographic and anthropometric of mother-child pairs (*n*=685)

Variable	NM pairs		SC pairs		OWT pairs		SCOWT pairs	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Child's gender (*P*=0.065)								
Male	87	12.7	60	8.8	115	16.8	81	11.8
Female	90	13.1	45	6.6	143	20.9	64	9.3
Mother's general literacy (*P*=0.059)								
Illiterate	8	1.2	12	1.8	23	3.4	14	2.0
Partially literate	18	2.6	15	2.2	33	4.8	28	4.1
Literate	151	22.0	78	11.4	202	29.5	103	15.0
Maternal education*** (*P*=0.000)								
No schooling	4	0.6	9	1.3	14	2.0	11	1.6
Primary	58	8.5	57	8.3	93	13.6	74	10.8
Secondary	34	5.0	19	2.8	58	8.5	27	3.9
High-school	64	9.3	19	2.8	78	11.4	26	3.8
College	17	2.5	1	0.1	15	15	7	1.0
Family type (*P*=0.410)								
Nuclear family	112	16.4	61	8.9	159	23.2	89	13.0
Extended family	65	9.5	44	6.4	99	14.5	56	8.2
Number of child at home** (*P*=0.006)								
1-2 children	141	20.6	77	11.2	177	25.8	87	12.7
3-4 children	31	4.5	25	3.6	77	11.2	54	7.9
>4 children	5	0.7	3	0.4	4	0.6	4	0.6
Number of under 5 years old children in the household (*P*=0.969)								
1 child	159	23.2	97	14.2	232	33.9	129	18.8
2 children	17	2.5	8	1.2	25	3.6	15	2.2
3 children	1	0.1	0	0.0	1	0.1	1	0.1
Maternal occupation (*P*=0.465)								
Housewife without maid	135	19.7	86	12.6	187	27.3	112	16.4
Housewife with maid	2	0.3	4	0.6	11	1.6	9	1.3
Government officer (PNS/BUMN/Army/Police)	1	0.1	0	0.0	2	0.3	0	0.0
Private sector	13	1.9	3	0.4	20	2.9	6	0.9
Trade and entrepreneur	15	2.2	8	1.2	19	2.8	9	1.3
Labor/miscellaneous services	11	1.6	4	0.6	19	2.8	9	1.3
Paternal occupation*** (*P*<0.001)								
Government employee (PNS/BUMN/Army/Police)	28	4.3	1	0.2	30	4.6	4	0.6
Private sector	60	9.2	26	4.0	72	11.1	34	5.2
Trade and entrepreneur	28	4.3	20	3.1	38	5.8	25	3.8
Labor	35	5.4	36	5.5	81	12.5	45	6.9
Other	20	3.1	17	2.6	24	3.7	26	3.9
Household's monthly income** (*P*=0.007)								
< Rp. 1,000,000 ($100)	25	3.7	18	2.6	50	7.3	32	4.7
> Rp. 1,000,000 – 1,500,000 ($100 – 150)	47	6.9	44	6.4	77	11.2	50	7.3
> Rp. 1500,000 – 2,000,000 ($150 – 200)	28	4.1	17	2.5	34	5.0	21	3.1
> Rp. 2,000,000 – 2,500,000 ($200 – 250)	11	1.6	12	1.8	27	3.9	13	1.9
> Rp. 2,500,000 – 3,000,000 ($250 – 300)	30	4.4	8	1.2	23	3.4	19	2.8
> Rp. 3,000,000 ($300)	36	5.3	6	0.9	47	6.8	10	1.5
Household's monthly food expenditure* (*P*=0.049)								
< Rp. 500,000 ($50)								
Rp. 500,000 – 1,000,000 ($50 – 100)	16	2.3	13	1.9	17	2.5	6	0.9
> Rp. 1,000,000 – 1,500,000 ($100 – 150)	71	10.4	54	7.9	118	17.2	68	9.9
> Rp. 1500,000 – 2,000,000 ($150 – 200)	51	7.4	28	4.1	90	13.1	51	7.4
> Rp. 2,000,000 – 2,500,000 ($200 – 250)	14	2.0	5	0.7	16	2.3	10	1.5

> Rp. 2,500,000 ($250)	13	1.9	4	0.6	7	1.0	5	0.7
	12	1.8	1	0.1	10	1.5	5	0.7

Note. NM pairs=Pairs with nutritional status of both mother (Body Mass Index or BMI between 18.5 to 25.0) and child (Height-for-age z-score/HAZ between -2 to + 2) was normal. SC pairs=Pairs with stunted child (HAZ less than -2) and normal mother (BMI between 18.5 to 25.0). OWT pairs=Pairs with overweight/obese mother (BMI>25.0) and normal child (HAZ between -2 to + 2). SCOWT pairs=Pairs with stunted child (HAZ less than -2) and overweight/obese mother (BMI>25.0). Values were significantly different from households with normal mother-child pairs: **P*<0.05, ***P*<0.01, ****P*<0.001. *P* was obtained with X^2 tests.

Nutrition literacy

Nutrition literacy was measured using a 28-item questionnaire about macronutrients, household food measures and food groups based on the Indonesian version of MyPlate, known as "*Piring Makanku*." The measure of central tendency and spread of nutrition literacy data across household categories is presented in Table 2.

Table 5.2 Descriptive statistics of household's categories based on mother-child pairs in relation to nutrition literacy, dietary diversity and food insecurity

Variable	Median	IQR	Skewness (SE)	Kurtosis (SE)
Nutrition literacy score				
NM Pairs	19	3.5	-0.630 (0.183)	0.822 (0.363)
SC Pairs	18	4.0	-1.256 (0.236)	2.933 (0.467)
OWT Pairs	18	3.0	-0.442 (0.152)	0.284 (0.302)
SCOWT Pairs	17	4.0	-0.746 (0.201)	2.154 (0.400)
Dietary diversity score				
NM Pairs	7	2.0	-0.013 (0.183)	0.362 (0.363)
SC Pairs	6	2.0	0.545 (0.236)	0.663 (0.467)
OWT Pairs	7	1.0	2.222 (0.152)	14.104 (0.302)
SCOWT Pairs	6	2.0	0.107 (0.201)	-0.152 (0.400)
The HFIAS score				
NM Pairs	1	6.0	1.361 (0.183)	0.815 (0.363)
SC Pairs	4	9.0	0.939 (0.236)	-0.002 (0.467)
OWT Pairs	2	7.0	1.311 (0.152)	0.961 (0.302)
SCOWT Pairs	5	9.0	0.818 (0.201)	-0.129 (0.400)

Note. IQR=Inter Quartile Range; SE=Standard Error; HFIAS=Household Food Insecurity Access Scale. NM pairs=Pairs with nutritional status of both mother (BMI between 18.5 to 25.0) and child (HAZ between -2 to + 2) was normal. SC pairs=Pairs with stunted child (HAZ less than -2) and normal mother (BMI between 18.5 to 25.0). OWT pairs=Pairs with overweight/obese mother (BMI>25.0) and normal child (HAZ between -2 to + 2). SCOWT pairs=Pairs with stunted child (HAZ less than -2) and overweight/obese mother (BMI>25.0)

As seen in Figure 1, the median of nutrition literacy was higher among households with normal mother-child pairs at 19, and it has an inter-quartile range (IQR) of 3.5, followed by OWT pairs (median=18; IQR=3.0), and SC pairs (median=18; IQR=4.0). Interestingly, maternal nutrition literacy was lowest among households with SCOWT pairs (median=17; IQR=4.0).

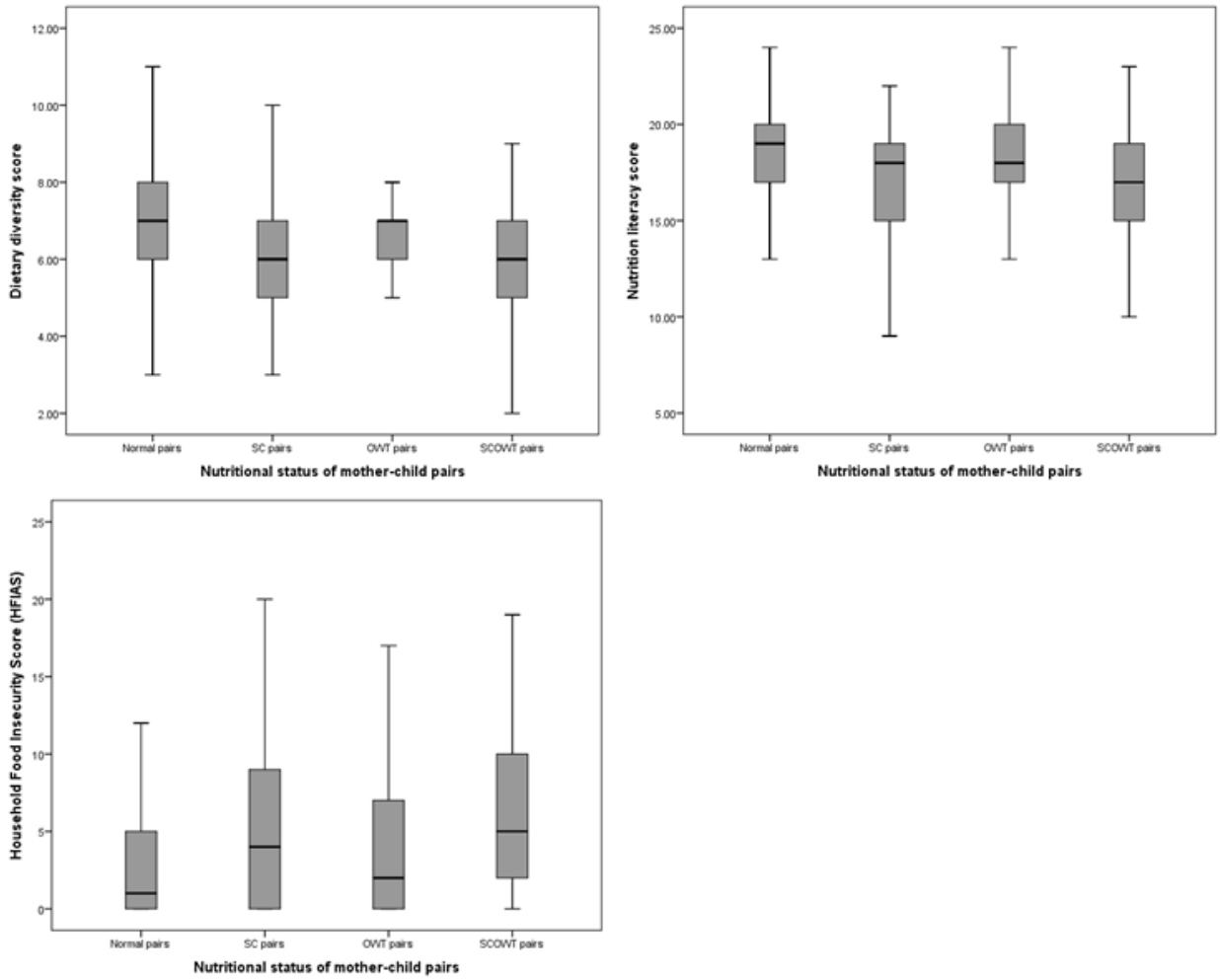

Figure 5.1 Boxplot of nutritional status of mother-child pairs in one household in relation to nutritional literacy, dietary diversity score and food security among urban households in Surabaya, Indonesia, in May 2015.

Similarly, in Table 4, the mean rank for the household categories was highest among normal pairs (392), followed by OWT pairs (361), SC pairs (290), and SCOWT pairs (289).

Table 5.3 Nutrition literacy, dietary diversity, food security and nutritional status of mother-child pairs.

Mother-child pairs	Nutrition Literacy			Dietary Diversity			FS1			FS2		
	Mean rank	***P***	**Eta-squared**	***Mean rank***	***P***	**Eta-squared**	***Mean rank***	***P***	**Eta-squared**	***Mean rank***	***P***	**Eta-squared**
Kruskal Wallis Test		<0.001**	0.046		0.000**	0.030		<0.001**	0.045		0.019*	0.015
NM Pairs	391.89			388.34			313.19			332.89		
SC Pairs	290.49			298.05			343.71			381.91		
OWT Pairs	361.32			349.05			318.85			352.18		
SCOWT Pairs	288.75			307.87			419.27			308.40		
Post Hoc Analysis												
SCOWT-NM		<0.001***	0.065		0.000***	0.042		<0.001***	0.073		0.182	0.006
SCOWT	135.33			141.05			188.14			153.51		
NM	182.94			178.25			138.64			167.17		
SCOWT-SC		0.849	0.000		0.691	<0.001		0.002***	0.038		0.007***	0.029
SCOWT	124.76			127.00			137.30			115.14		
SC	126.52			123.42			109.20			139.80		
SCOWT-OWT		<0.001***	0.031		0.032	0.011		<0.001***	0.062		0.033	0.011
SCOWT	174.66			185.82			239.82			185.75		
OWT	217.37			211.09			180.74			211.13		
NM-SC		<0.001***	0.062		0.000***	0.049		0.200	0.006		0.028	0.017
NM	157.05			155.07			136.34			132.99		
SC	115.30			118.62			148.81			154.42		
NM-OWT		0.099	0.006		0.049	0.010		0.746	0.000		0.270	0.003
NM	229.91			233.02			215.22			209.73		
OWT	209.83			207.69			219.06			222.80		
SC-OWT		0.001***	0.028		0.017	0.016		0.248	0.004		0.164	0.005
SC	154.67			162.00			191.70			193.69		
OWT	193.12			190.14			178.05			177.24		

Note. NM pairs=Pairs with nutritional status of both mother (BMI between 18.5 to 25.0) and child (HAZ between -2 to + 2) was normal. SC pairs=Pairs with stunted child (HAZ less than -2) and normal mother (BMI between 18.5 to 25.0). OWT pairs=Pairs with overweight/obese mother (BMI>25.0) and normal child (HAZ between -2 to + 2). SCOWT pairs=Pairs with stunted child (HAZ less than -2) and overweight/obese mother (BMI>25.0). FS1=Food quality as a measure of food security derived from principle component analysis. FS1=Food intake as a measure of food security derived from principle component analysis. 685 among 700 households with non-missing variables were used for the Kruskal-Wallis test and sub-sequent post-hoc analysis. Values were significantly different for Kruskal Wallis test: **P*<0.05, ***P*<0.001. Values were significantly different for *Post Hoc* Analysis with Bonferroni Correction: ****P*<0.0083.

As seen in Table 4, a non-parametric analysis performed with the Kruskal-Wallis test showed a significant difference among household categories based on the nutritional status of mother-child pairs (P<0.001). The follow-up post hoc analysis revealed that there was significant difference in maternal nutrition literacy between households with SCOWT pairs and households with normal pairs (P<0.001) as well as OWT pairs (P<0.001), but no significant difference was revealed for SC pairs (P=0.849).

Dietary diversity

Dietary diversity was assessed using the 16-item questionnaire for measuring dietary diversity, and then compressing it into 12 food groups (FAO, 2010). Table 2 shows mother-child pairs of normal anthropometric status having a relatively modest score for dietary diversity (median=7; IQR=2.0), scores are relatively similar for OWT pairs but with lower IQR (median=7; IQR=1.0), but still higher than the SCOWT pairs (median=6; IQR=2.0) and SC pairs (median=6; IQR=2.0). A similar pattern was observed in the distribution of mean rank of dietary diversity that was higher among households with normal pairs (388), followed by OWT pairs (349), SCOWT pairs (308) and SC pairs (298). In Table 4, the Kruskal-Wallis test found that there was significant difference among the four household categories (P<0.001). The post-hoc analysis with Bonferroni correction showed a difference between normal pairs and SCOWT pairs (P<0.001), and also between normal pairs and SC pairs (P<0.001).

Food security

Food security was measured using the Household Food Insecurity Access Scale (HFIAS) that consists of 9-items followed by questions regarding the frequency or occurrence of the event

described in the items. The range of the HFIAS was between 0, indicating absolute food security, to 27, indicating a household undergoing severe food insecurity. Households with normal mother-child pairs were shown to be the most food secure (median=1; IQR=6.0), followed by the OWT pairs (median=2; IQR=7.0), SC pairs (median=4; IQR=9.0) and last, the SCOWT pairs (median=5; IQR=9.0). We employed a dimension reduction technique using principle component analysis (PCA) with Varimax rotation. Two factors emerged as food security measures. As seen in Table 3, the first factor was related to possible disruption of "food quality," and the second factor emphasized concerns about lack of "food quantity" in the household for the last 4 weeks. Table 4 showed that there was significant difference in food security measures in terms of both "food quality" (P<0.001) and "food quantity" (P=0.019) between the four pair categories based on the Kruskal-Wallis test. In the post-hoc analysis with Bonferroni correction we found that the "food quality" measure, was significantly different between households with SCOWT and normal pairs (P<0.001), SC pairs (P=0.002) as well as OWT pairs (P<0.001). In the "food quantity" measure, only SCOWT and SC pairs were significantly different (P=0.007).

Discussion

The objective of the current study was to analyze the difference in maternal nutrition literacy, dietary diversity and food security of four household categories based on nutritional status of maternal-child pairs. Our results showed that there were significant differences in maternal nutrition literacy, dietary diversity, and PCA-derived food security measures (quality of food and quantity of food). However, in the subsequent post-hoc analysis with Bonferroni correction, maternal nutrition literacy and lack of food quality was distinctly different in the SCOWT and OWT households only. These results negate previous arguments that suggested SCOWT was not

a distinct entity and merely a statistical artifact (Dieffenbach & Stein, 2012). Whether households with SCOWT pairs were biologically distinct, aligning with theory of the Developmental Origins of Health and Disease (DOHaD) (Sata, 2016), for example, is yet to be confirmed. Even though the design was cross-sectional, our study controlled measurement bias relatively well compared to the previous study that was based on analysis of secondary data.

Previous evidence showed that SCOWT prevalence was highly dependent on the prevalence of maternal overweight (Dieffenbach & Stein, 2012). Although the prevalence of OWT households was higher than other household categories, our study found that the prevalence of SCOWT was not dependent or having multi-collinearity with the prevalence of OWT pairs. The maternal nutrition literacy among SCOWT households was significantly lower, while the PCA-derived measure of "food quality" representing a household's lack in "preferred" foods was significantly different from households with an OWT pair. The SCOWT households were reported to have significantly higher lack of "food quality" but not "food quantity" in comparison to the OWT households. These results aligned with the finding from a study in Guatemala that showed SCOWT was most prevalent among households with per capita consumption in the middle quintile (Lee et al., 2012). The observed maternal nutrition literacy that was lower among SCOWT households indicate that a mother, who in most cases in developing countries, is responsible for the household's grocery shopping was not equipped to make healthy food choices even when a shortage of foods was not a problem. Our claim that households with SCOWT pairs was distinctly different from OWT and SC only pairs was supported by the fact that there was no significant difference between the lack of "food quantity" between households with SCOWT and OWT pairs, while there was a significant difference in the lack of "food quantity" between households with SCOWT and SC pairs. Households with SCOWT pairs were believed to be food secure as they

did not have to compromise their meals like the SC households, but they did have limitations in terms of preferred foods consumed compared to the OWT households. These findings emphasize the importance of behavioral strategies to enable mothers to make healthy food choices on a limited budget.

Even though our study did not measure fat and protein content of foods consumed by the four households categories, we did analyze the data from the household dietary diversity score (HDDS) as an estimate of the typical diet. Our post hoc analysis revealed that the difference in dietary diversity was significant between households with SCOWT pairs compared to normal pairs, but there was no significant difference in dietary diversity between SCOWT and OWT or SC pairs. These results support the previous study that showed distinct characteristics of the SCOWT households such as higher fat and protein content in foods consumed (Sekiyama et al., 2015). The "underweight only" and normal weight households were not as easy to distinguish when compared to the "overweight only" households in the previous study (Doak et al., 2002).

The Chi-Squared test revealed a significant difference among the four household categories in terms of maternal education, number of children living in the same house, father's occupation, household monthly income, as well as monthly food expenditure. Paternal occupation in households with SCOWT was less steady in terms of income compared to the normal household. While the percentage of household earning more than IDR 2,500,000 ($250 USD) was higher among OWT pairs (10.2%) than SCOWT pairs (4.3%) and SC pairs (2.1%). We saw that in terms of monthly income, the discrepancy between SCOWT households was wider with OWT households than with SC households. These results are in line with the suggested etiology of the double burden of malnutrition (Jehn & Brewis, 2009). When the household income increased as a result of steady occupation, positive energy was almost inevitable due to increased intake of

energy-dense food and worsened by sedentary work (Dieffenbach & Stein, 2012; Jehn & Brewis, 2009). It was believed that household food choice was dominated by energy-dense foods and not nutrient-dense foods. Nutrient-dense foods were influential in improving child nutritional status and the prevention of stunting in the household. Prevention of stunting should be emphasized by providing adequate nutrients to assist a child's rapid growth during the first 1,000 days of life (Victora & Rivera, 2014).

However, part of our *a priori* hypothesis was not supported in this study. Even though nutrition literacy was significantly different for households with SCOWT pairs when compared to households with the OWT pairs, the dietary diversity was not significantly altered. This finding indicates that knowledge alone is not enough to change behavior (Corace & Garber, 2014). Therefore, future studies and efforts for behavioral change such as improving dietary diversity among populations undergoing nutrition transition should be directed toward behavioral-based interventions targeting potential mediators that could enhance adoption such as self-efficacy, positive outcome expectations and building support systems

Strengths and limitations

By employing 99% power with a 5% margin of error and relatively large sample size, this study was fully-powered, to support a precise and accurate conclusion. Furthermore, the structured questionnaires used in this study such as the nutrition literacy questionnaire, dietary diversity questionnaire and food security questionnaire were validated in the previous studies These questionnaires were administered by trained interviewers in the comfortable setting of the participant's house to limit interviewer bias.

A few limitations might arise from this study. As is true for other surveys, drawing causal inference for the difference features of SCOWT in terms of maternal nutrition literacy, dietary diversity and food security is not possible. Low level of internal consistency was observed for all of the 3 domains of nutrition literacy and dietary diversity indicated by Cronbach's alpha of less than 0.65. Even though the questionnaires used in the study were previously validated in other peer-reviewed publications, adaptation to the local context in Indonesia might affect their validity. Several covariates in this study such as maternal education, number of children living in the same house, father's occupation, household monthly income, and monthly food expenditure, might have hindered the observed difference. Even though our study was fully powered, the use of *posyandu* as the basis for recruitment might limit the representation of children that did not register in *posyandu*. Since we selected sub-districts with prevalence of child underweight of more than 15% for data collection we believed that variation between *posyandus* arising from clustered sampling was minimized, however, generalization of results to other areas with low level of malnutrition might be limited.

In conclusion, this study failed to support the hypothesis that the double burden of malnutrition in the form of SCOWT is a statistical artifact. Households with SCOWT pairs were significantly different compared to other household categories in terms of food security measured as limited food quality. These households were also significantly different from those with OWT pairs in terms of maternal nutrition literacy and significantly different from SC pairs in terms of food security measured as lack of food quantity. However, no significant difference in dietary diversity was observed between households with SCOWT pairs and OWT pairs or SC pairs. Behavioral interventions targeting households with SCOWT pairs should emphasize improving healthy food choices with foods containing high-quality nutrients.

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Chapter 6 - Effectiveness of Nutrition Education to Reduce the Double Burden of Malnutrition: Study Protocol for a Randomized Controlled Trial

Note. This chapter is currently under review in the BMC Public Health.

Abstract

Background: Rapid changes in food patterns and nutrient intake when populations adopt modern lifestyles during economic and social development, urbanization and acculturation have led developing countries to face the so-called nutrition transition. Consequently, these countries suffer from the double burden of malnutrition, consisting of unresolved under-nutrition and the rise of overweight/obesity. The prevalence of double burden of malnutrition tends to be highest for moderate levels (third quintile) of socioeconomic status. Evidence suggests that modifiable factors such as food distribution and dietary diversity are associated with double burden of malnutrition, given household food security. This article aimed to describe the study protocol of behaviorally based nutrition education intervention for overweight/obese mother with stunted children (NEO-MOM) in reducing double burden of malnutrition.

Methods/Design: NEO-MOM is a randomized controlled trial with 3 months of behavioral intervention for households involving stunted children and overweight/obese mothers (SCOWT). The SCOWT pairs will be randomly assigned to either intervention group or a comparison group, which receives usual care plus printed educational materials. The intervention will consist of 6 sessions of in-class nutrition education and home visits performed by trained

community health workers using a motivational interviewing approach. The primary outcomes of this study are the prevalence of double burden of malnutrition as SCOWT, child's height-for-age Z-score (HAZ) and maternal BMI.

Discussion: Since previous studies are mainly observational in nature, this study pushes the boundary forward in understanding double burden of malnutrition through a fully powered randomized controlled trial. The intervention provides the potential to achieve participant self-administered goal setting to improve diet, as well as child feeding behavior, by means of improved self-efficacy. Maternal self-efficacy is potentially enhanced by vicarious experience and active mastery experience gained during 6 sessions of nutrition education and verbal persuasion during home visits.

Trial registration: The Universal Trial Number (UTN) for this study is U1111-1175-5834. This trial is registered in the Australian New Zealand Clinical Trials Registry (ANZCTR) and is allocated the registration number: ACTRN12615001243505.

Keywords: nutrition education, motivational interviewing, self-efficacy, home visit, stunting, overweight, obesity, double burden of malnutrition

Background

Children of the world still suffer from malnutrition, and more than 25% of under-five children in developing countries are stunted (World Health Organization [WHO], 2006). Stunted children do not grow well, and they are shorter in stature than normal children of their age. Childhood stunting is associated with sub-optimal brain development that leads to impaired cognitive ability, school performance and lesser potential earning later in life (United Nations

Children's Fund [UNICEF], 2013). Acknowledging the detrimental consequences of child stunting, WHO and its member countries have pledged to achieve a 40% reduction by 2025 through the Scaling up Nutrition (SUN) program (UNICEF, 2013).

While the battle with stunting is far from over, developing countries have been hampered by another spectrum of nutrition problem. Increasing rapidly among the adult population, especially females, overweight and obesity is posing a serious health and economic burden, due to later complications with chronic diseases. In the mid-1990's, Popkin observed that the phenomenon of coexistence between overweight and obesity and under-nutrition mostly occurred in developing countries (Popkin, 1994). Since then, double burden of malnutrition has raised public health concerns regarding its consequences. First, it will increase the burden of disease due to under-nutrition with deficiency in vitamins, minerals and protein. Over-nutrition increases the risk for non-communicable disease (NCD), including obesity, hypertension, type 2 diabetes, and cardiovascular diseases; the presence of NCDs accounted for 80% of the total disease mortality burden in developing countries, with an estimated US$84 billion of economic production lost attributable to heart disease, stroke, and diabetes alone (Abegunde, Mathers, Adam, Ortegon, & Strong, 2007). Hence, the presence of double burden of malnutrition poses additional hardship on the already inadequate and overextended health budget in developing countries (Delisle, Agueh, Fayomi, 2011).

Most developing countries have been experiencing the so-called nutrition transition, rapid changes in dietary patterns and nutrient intakes when populations adopt modern lifestyles during economic and social development, urbanization and acculturation (Popkin, 1994). Popkin has argued that the double burden of malnutrition in one household is related to urbanization (Popkin, 2005). As urbanization happens, the household increases their level of income, and

food is more available in terms of quantity, but not in quality (Kolopaking, Bardosono, & Fahmida, 2011). Available food tends to be high in energy, but low in micronutrients and protein that affect child growth, especially child height. If children receive insufficient micronutrients and protein in the first two years of life, there is an increased risk for the child to be stunted (UNICEF, 2013). Mothers, if they consume high-energy food accompanied by low physical activity, will have increased risk of maternal overweight and obesity.

Indonesia, the fourth most populous country in the world, has suffered from the double burden of malnutrition. The prevalence of child stunting in Indonesia was 36.8%, 35.6% and 37.2% in 2007, 2010 and 2013, respectively (Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan RI [Balitbangkes], 2013). On the other hand, the prevalence of obesity (BMI>27) among women (aged>18 years old) was increasing continuously. In 2007 the obesity prevalence among women was only 13.9%, in 2010 it was 15.5% and in 2013 it was 32.9% (Balitbangkes, 2013). Some have suggested that East Java Province is a microcosm of Indonesia in terms of achievement in child health outcomes in Indonesia. The prevalence of child stunting in East Java was similar to the national figure of around 35% (Balitbangkes, 2013). A study in rural Indonesia showed that the prevalence of coexistence between form of child under-nutrition that include stunting and maternal overweight/obesity (SCOWT) was 11% (Oddo et al., 2012).

A previous study revealed that the prevalence of double burden of malnutrition reaches the highest prevalence, at 22.7%, among the middle (third) quintile of socioeconomic status (SES) in a Guatemalan population (Lee, Houser, Must, Fulladolsa, & Bermudez, 2012). This evidence suggests that at the household level, in the absence of food insecurity and economic deprivation, modifiable factors such as food distribution and dietary diversity were associated with the high prevalence of double burden of malnutrition in this third quintile group, relative to

the others. We hypothesize that stunted children in households that suffer from the double burden of malnutrition are less likely to be facing food insecurity. We aim to target the modifiable behaviors related to double burden of malnutrition in an urban setting of Indonesia through Nutrition Education for Overweight/Obese Mother with Stunted Children (NEO-MOM) intervention. This article describes the rationale and methods for the randomized controlled trial conducted in urban Indonesia to reduce the prevalence of double burden of malnutrition in the form of stunted child and overweight/obese mother (SCOWT) pairs.

Methods

This RCT will be a superiority trial that consists of 2-arm parallel groups design in households with stunted children and overweight/obese mother (SCOWT pairs). After an initial screening procedure, 72 women who consent to participate with stunted children will be randomized to either the intervention or comparison group. This study will employ parallel assignment where different groups of participants receive different interventions during the same time span of the study. There are 2 groups: on top of receiving usual care from Indonesian government, one group received additional with printed educational materials (PRINT) and the other received an enhanced behavior change intervention group (NEO-MOM). Each group was allocated with 36 overweight/obese mothers and respective stunted child. All participants visited at home at the beginning of the study for baseline data and at the end of the study after 3 months intervention to collect post intervention data. The adapted CONSORT diagram in Figure 1 shows progression through the study for individual participants.

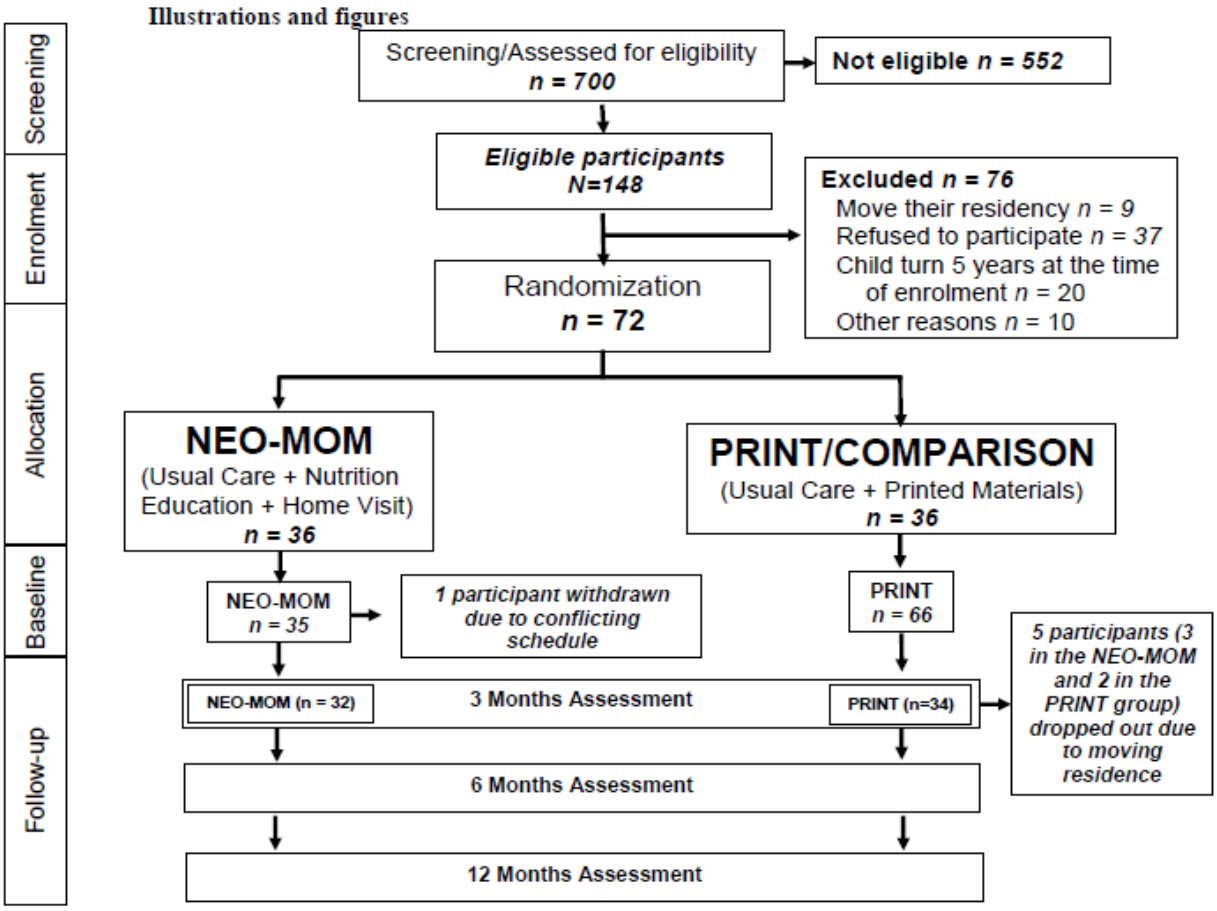

Figure 6.1 Adapted CONSORT diagram of the study

Objective and hypothesis

The objective of this RCT is to evaluate the effectiveness of a behaviorally based nutrition education (NEO-MOM) intervention, relative to a printed educational materials comparison group, in reducing household double burden of malnutrition, as indicated by stunted child and overweight/obese mother (SCOWT) pairs.

Primary hypothesis

The NEO-MOM intervention, consisting of 6 sessions of behaviorally based nutrition education and home visits, will be more effective in reducing SCOWT prevalence in the intervention group, relative to the comparison group.

Secondary hypothesis

We hypothesize that relative to the comparison group, after 6 sessions of behaviorally based nutrition education intervention (NEO-MOM) accompanied with biweekly home visits, the intervention group will:

1. Show greater increases in their average maternal fruit and vegetables intake and also their average child's animal protein intake, relative to the comparison group.
2. Have greater increases in maternal self-efficacy for fruit and vegetable intake, as well as improved child-feeding behavior, relative to the comparison group.
3. Show greater increases in maternal physical activity (average number of steps per day assessed via pedometer), relative to the comparison group.
4. Have larger reductions in maternal sedentary time, relative to the comparison group.

Ethical approval

The Institutional Review Board (IRB) at Kansas State University approved this trial (reference or proposal number: 7894), the screening portion was also approved by the IRB in Kansas State University (reference or proposal number: 7646). In addition, this trial was approved by the Surabaya City Review Board (Bakesbangpol No: 1366/LIT/2015) Indonesia. The main ethical consideration is to ensure that the risk of harm to participants is minimized and they are fully informed of any risk. Religious and cultural sensitivities are taken into account when obtaining informed consent. We will handle recruitment and informed consent in such a way that potential participants are not put under pressure to participate, and confidentiality is preserved. All participant data are stored using code system and electronic data are password protected.

We will obtain informed consent during monthly community health post meeting (posyandu), where mothers usually bring their under-five years-old children for growth monitoring. Our research assistants will invite potential participants to meet in a separate room, and they will be given verbal and written information about the study, and at least one week to think about participating. Participants are free to withdraw from the study at any time without negative consequences.

We will keep a copy of participant informed consent for 12 months after the completion of the study. Personal data with participant identification will be destroyed after 3 years of study completion. We will archive other records for five years before being destroyed.

The Universal Trial Number (UTN) for this study is U1111-1175-5834. This trial is registered in the Australian New Zealand Clinical Trials Registry (ANZCTR) and is allocated the registration number: ACTRN12615001243505. The ANZCTR is recognized as an ICMJE acceptable registry and a Primary Registry in the WHO registry network.

Setting

The study is set in urban city of Surabaya, Indonesia. Surabaya is the second largest city in Indonesia with over 3.1 million inhabitant and 5.6 million in the metropolitan area (Badan Pusat Statistik Kota Surabaya [BPS Surabaya], 2013). Popkin (1994) has argued that one of the driving forces for double burden of malnutrition is urbanization, and Surabaya is a prime setting for studying the phenomenon of nutrition transition and double burden of malnutrition. Surabaya has a big port and industries that make it a melting pot for urbanization from the eastern part of Indonesia. The advantages for choosing Surabaya as the setting of this study are: it spans the range of population densities, urbanization, and socioeconomic profiling. Since Indonesia is an

archipelago country, to recruit participants from every major city in each island is cost prohibitive. A limitation, however, is that Surabaya may not be representative of the rest of urban cities in Indonesia, and may not address health and nutrition inequalities across islands. However, there are many pockets of health and nutrition inequalities within Surabaya City (Siswanto, Routray, & Dewi, 2014) that mirror the rest of urban setting in Indonesia.

Target population

The sampling frame is community health post ("posyandu") (Mahmudiono, 2007) with list sizes greater than 50 mothers with their respective under-five year old children. The case definition includes overweight/obese mothers (BMI>25) with stunted children (HAZ<-2). Repeated anthropometric measurement for both mothers and children are performed by trained research assistance in *posyandu*. If the discrepancy between the first and the second measurement is greater than 1%, a third measurement will be initiated. An average of anthropometric measurements will be used to determine eligibility. Following screening via anthropometric measurement, we will invite those who are potentially eligible to participate in the study. Informed consent is gained from all participants prior to undergoing screening in order to validate their eligibility to participate. BMI cut-off point of >25kg/m^2 is used to determine maternal overweight and obesity, while child stunting is defined as HAZ <-2.0, according to WHO-Anthro 2005 reference.

Inclusion and exclusion criteria

The inclusion criteria for participants are: fluent in conventional Bahasa Indonesia language, permanent resident and planning to stay in Surabaya City for at least 6 months, mother

of a stunted child under the age of five years, and being overweight/obese. In addition, the child has to be registered in *posyandu* and receiving food supplementation from the Indonesian government known as the *Pemberian Makanan Tambahan (PMT) Pemulihan* (Kementerian Kesehatan Republik Indonesia [Kemkes RI], 2011). The exclusion criteria are: either the mother or the child has physical disability; mother is participating in a weight loss program or deliberately fasting due to a spiritual deed; or if child is diagnosed with serious medical problems.

Power calculation

The power calculation of our main outcome variable is based on the previous RCT in Bangladesh, with a similar 3-months long nutrition education intervention, along with complementary feeding on child's height gain (Imdad, Yakoob, & Bhutta, 2011; Roy et al., 2005). Although our study will not directly provide complementary feeding, one of our inclusion criteria is that participants in our study must receive complementary feeding program from the government of Indonesia. The effect size of provision of complementary food and intensive nutrition education on height gain (cm) in Bangladesh was 0.80 (95%CI=0.007-1.53) (Roy et al., 2005). We select this fairly large effect size of 0.8 expressed as mean difference in child's height, which translates to an ability to detect a difference between two groups of 0.80 cm child's height at 3 months follow-up. Our study will have a 90% power to detect changes that may be modest at the individual level, but will have an important impact if occurring at the population level. A minimum total sample size of 66 is needed to detect these differences according to our primary hypothesis, with two-tailed alpha of 0.05. Assuming dropout rate of 9%, the total sample size of 72 will be required (36 in intervention group and 36 in control group/usual care).

Randomization and allocation concealment

Randomization of participants will be performed using computer-generated random numbers. After assigning random numbers to the 72 consented participants, we will rank the list of participants based on the random numbers. The 36 participants in the upper rank will be allocated to intervention group (NEO-MOM) and the remaining 36 participants will be allocated to the comparison group. Due to the nature of the intervention, blinding for both researchers and participants is not possible. However, we will blind the assessor for baseline and evaluation data collection.

Behaviorally based nutrition education

The framework of Social Cognitive Theory (SCT) is underlying the intervention of the study that focus on behavior change through reciprocal determinism that incorporates interplay of person, environment and behavior at its core (Bandura, 1989). Bauman, Sallis, Dzewaltowski, and Owen (2002) argued that mediating factors lie in the pathways of behavior change. In the present study, maternal behavioral change related to overweight/obesity may be influenced by self-efficacy for including more fruit and vegetables in the family menu, while including more animal protein in children's diet for improved iron intake and protein absorption needed for growth. The behavioral mediators are part of the person side in SCT's reciprocal determinism. The core concept of SCT is laid in the importance of others in shaping people's behavior. Materials for nutrition education including booklets for all participants were developed based on the tenets of Social Cognitive Theory (SCT) (Figure 2). This study address several means to enhance maternal self-efficacy such as mastery experience in making healthy menu, peer group

modeling towards child feeding practices or engaging physical activity as well as inducing desire to include fruit and vegetables in their daily home meals.

Since the problem of maternal-child double burden of malnutrition had twofold of opposite nutritional problem, the target behaviors for this project are also addressing both childhood stunting and maternal overweight/obesity. For mothers, the target behavior is fruit and vegetable consumption, since both play a critical role in overweight/obesity prevention efforts. While for the child, the target behavior is increased consumption of animal protein food as well as fruit and vegetables.

We will identify manuals published in Bahasa Indonesia or in English in the last five years to improve maternal fruit and vegetables intake as well as to increase child intake of animal protein. Both peer-reviewed articles and grey literature will be searched and translated into Bahasa Indonesia. Two or three cycles of an iterative process will be conducted to draft and refine the manuals.

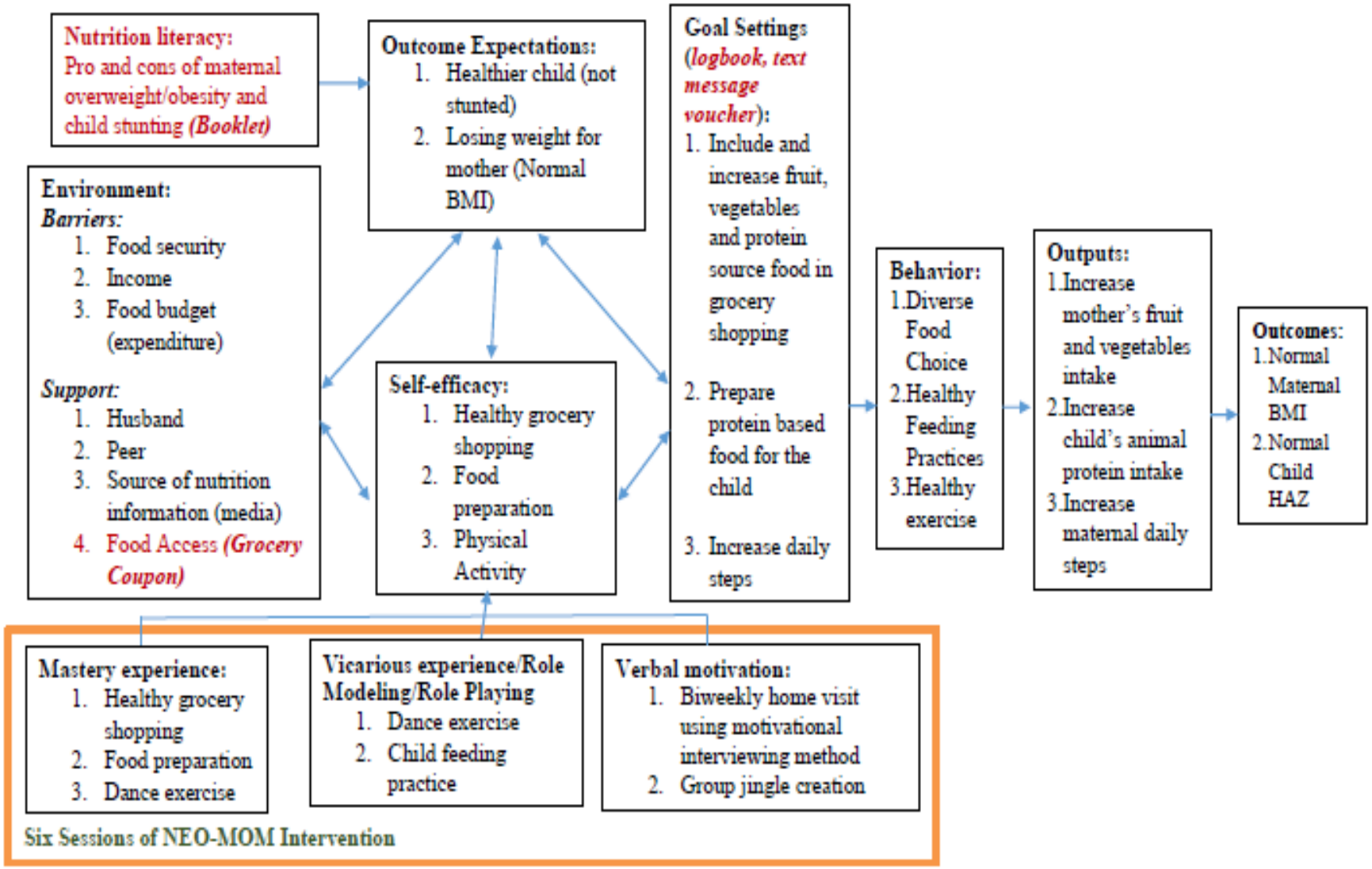

Figure 6.2 Construct of NEO-MOM Intervention Based on Social Cognitive Theory

Training community health worker

A month prior to the intervention, we will train community health worker on motivational interviewing. Motivational interviewing is a collaborative, goal-oriented style of communication commonly used in behavioral change in health care. It is designed to strengthen personal motivation for, and commitment to, a specific goal by eliciting and exploring the person's own reason for change within an atmosphere of acceptance and compassion. The core skills of motivational interviewing consist of: open question, affirmations, reflections and summaries. Community health workers will use motivational interviewing during biweekly home visits in the intervention group to give verbal encouragement and ways to overcome potential barriers for mother to achieve their goals. The training program will require 1 full day to complete, and will be led by study investigators. The training will involve a combination of didactic learning, role-playing, and case study discussion.

Intervention

All participants (NEO-MOM and PRINT Group) will receive 6 sets of educational materials in the form of booklets that described strategies to improve the health of stunted children as well as overweight mothers aligned with the tenets of Bandura's Social Cognitive Theory (SCT) (Bandura, 1989). In addition, mothers will be provided with grocery voucher upon their consent to participate in the study during baseline and evaluation phase.

The intervention group or NEO-MOM Group will receive 6 sessions of assisted behaviorally based nutrition education focusing on healthy food choice and child feeding practices and 6 sessions of motivational interviewing through home visits by a trained community health worker. Mothers will also get one biweekly grocery voucher every time they

attend a nutrition education session as an appreciation for their time and commitment toward the study. Participants will be able to use the grocery voucher after baseline assessment period until the end of intervention period. Through collaboration with grocery stores, we will be able to assess the actual purchase of the grocery voucher in the future study, however, this was not intended to be part of our outcomes evaluation in the current study. The session will be conducted on a biweekly basis. In total, the intervention spans 3 months. The approximate duration of each nutrition education session is 100 minutes, consisting of a 50-minute class session, followed by 50 minutes of hands-on experience. The session will be administered to mothers, allowing any of their children who came along to sit in. Our research assistants and community health workers will be present during the session to help handling the children if necessary. During the sessions of nutrition education, we will provide hands-on activities for mothers to improve their self-efficacy toward dietary diversity, healthy eating and child feeding. These activities will enable mothers to cope with basic household and environmental obstacles.

Table 6.1 Intervention components

Construct of Social Cognitive Theory	Behavior mechanism impacted	NEO-MOM Session	Intervention components
Provide information on health risk of maternal overweight/obesity and child stunting	Mechanisms affecting belief formation/cognitive mechanisms towards maternal nutrition literacy	Session 1	50 minutes nutrition education class on the introduction on the double burden of malnutrition, especially consequences and management of overweight/obesity and child stunting.
Outcome expectation	By improving maternal nutrition literacy, mothers might expect healthier child (their child not stunted) and improving maternal nutritional status (not overweight/obese)	Session 3	50 minutes nutrition education class on Indonesian balance diet and Indonesian version of MyPlate followed by healthy behavior message to improve fruit and vegetable consumption for mother, serve more animal protein for the child and increase maternal daily steps.
Environment (Food Access, peer support)	With supportive environment, performing intended healthy behavior will be easier	Session 1-6	Mothers in intervention group gathered every two weeks during nutrition education class that provide bonding and peer support. Access of food increased by distribution of grocery voucher every time mothers in the

			intervention group attend the nutrition education session.
Mastery Experience	By performing intended behavior during nutrition education class or during the hands-on activities session will improve maternal self-efficacy on performing these behavior: 1. Healthy grocery shopping 2. Food preparation 3. Physical Activity	Session 2 Session 1-6 Session 3 Session 4	50 minutes nutrition education class on healthy grocery shopping followed by 30 minutes mocked grocery shopping. 20 minutes dance session 30 minutes menu making for under five year old children with emphasize of including animal protein (chicken liver, catfish or eggs). 30 minutes nutrition education class on healthy cooking method followed by 60 minutes cooking demonstration
Goal setting	Assisted planning and goal setting will make behavior change perceived as attainable by mothers.	Session 1 Session 6	30 minutes hands-on experience on making goal setting to improve physical activity (as in daily steps), fruit and vegetable intake for mother and serving animal protein for their children 50 minutes FGD on how to overcome barriers towards child feeding practice followed by 30 minutes creation of pledge and strategies to tackle stunted child and overweight/obese mother (SCOWT) from mothers own perspective.
Vicarious Experience	By watching video of how others can perform responsive feeding, maternal self-efficacy will improve for preparing more animal protein for their child.	Session 5	50 minutes nutrition education class on Child feeding practice with emphasize of responsive feeding
Verbal Motivation	Verbal motivation from a respected informal leader such as community health worker will improve maternal self-efficacy on: 1. Healthy grocery shopping 2. Food preparation 3. Physical Activity	Home visit Session 6	The motivational interviewing delivered through home visit (6 times throughout the study administered in alternate week from nutrition education class and hands-on activity session) will focus on providing verbal motivation for mothers to achieve their biweekly goal setting (consist of: improving daily steps, fruit and vegetables intake, and serving child with animal protein), and help them with strategies to overcome barriers. 30 minutes role play and jingle/song making related to combating child stunting.

As seen in Table 1, the general content of the 6 sessions of nutrition education are: session 1) 50 minutes nutrition education class on the introduction on the double burden of

malnutrition, especially consequences and management of overweight/obesity and child stunting. This will be followed by 20 minutes of dancing, and 30 minutes of hands-on experience for goal setting to improve physical activity (as in daily steps), fruit and vegetable intake for mothers, and serving animal protein for their children; session 2) 50 minutes of nutrition education class on healthy grocery shopping followed by 20 minutes of dancing and 30 minutes of mock grocery shopping session 3) 50 minutes of nutrition education class on Indonesian balanced diet and Indonesian version of MyPlate, followed by 20 minutes of dancing and 30 minutes menu making for under children under five, with an emphasis on including animal protein (chicken liver, catfish or eggs); session 4) 30 minutes of nutrition education class on healthy cooking method, followed by a 20-minute dance session and 60 minutes cooking demonstration; session 5) 50 minutes of nutrition education class on child feeding practices with emphasis on responsive feeding, followed by 20 minutes of dancing and 30 minutes role playing and jingle/song making related to combating child stunting; session 6) 50 minutes on how to overcome barriers towards child feeding practice, followed by a 20-minute dance session and 30 minutes creation of pledge and strategies to tackle stunted child and overweight/obese mother (SCOWT) from the mothers' own perspective.

Our co-investigators in Indonesia will carry out the classes of nutrition education. They are faculty members of Department of Nutrition, Universitas Airlangga with expertise in nutrition and behavioral change intervention. All of them hold a master's degree in public health or community nutrition. Our trained research assistants will be responsible for delivering the hands-on experience session. All of our research assistants hold a bachelor's degree in public health nutrition.

The motivational interviewing will be delivered through home visit (6 times throughout the study, administered in alternate weeks from nutrition education class and hands-on activity session) and will focus on providing verbal motivation for mothers to achieve their biweekly goal setting (consisting of improving daily steps, fruit and vegetable intake, and serving child meals with animal protein), and helping them with strategies to overcome barriers. The motivational interviewing session will last for approximately 1 hour. Community health workers will be conveying the motivational interviewing session (through home visit). These trained community health workers are regarded as community informal leader in participants' living area.

Comparison group: usual care plus printed educational materials

The comparison group will not have any nutrition education or home visits by a community health worker. Participants in the comparison group will receive sets of printed educational materials, coupled with a government food supplementation program. The sets of printed educational materials (booklets) will be provided to them after baseline data measurement. Printed material was chosen as the medium for source of information due to several considerations: first, it mimics government strategy for distributing the health messages through the "*Kartu Menuju Sehat*" (KMS) or a child's growth monitoring card; second, it was deemed unethical not to provide anything for participants knowingly that they had double burden of malnutrition in the form of SCOWT; lastly, these materials were provided to minimize the threat to internal validity. Behi & Nolan (1996) argued that internal validity to the intervention study could be compromised if the control or comparison groups were aware that they received less desirable treatment compare to other group. Hence by providing the comparison group with

the same printed educational materials, we aimed to avoid resentful demoralization of participants in the comparison group. All mothers participating in this study will receive usual care in the form of monthly growth monitoring of their child nutritional status at *posyandu*, and supplementary feeding program from Indonesian government.

Primary outcome

Measurement of outcomes will be collected at baseline and at the end of the study (3 months). The primary outcome should be that for which the study was powered. Therefore, our primary outcome in this study will be changes in child's height (cm). Details of height measurement are found within anthropometric data. The same methods of assessment at baseline will be used.

Secondary outcomes

Secondary outcomes for this study will be consisted of variables from anthropometric data, lifestyle data, and psychological data.

Anthropometric data

The secondary outcome measured in this study will be maternal overweight/obesity, child's stunting and double burden of malnutrition in the form of SCOWT. We will collect data on child's age, weight, and height, as well as maternal weight, height, and waist circumference. Weight will be measured in light clothing, without shoes or flip flop, on Camry EB6571 digital scale (Guangdong, China) to 0.01 kg for weight. Height will be measured to the nearest 0.1 cm using a portable stadiometer (SECA 213). Maternal weight and height measurement will be used

to calculate BMI. Waist circumference will be measured horizontally halfway between the lowest rib and the upper prominence of the pelvis using a non-extensible steel tape (MyoTape) against the bare abdomen. We will measure the change in maternal body mass index (BMI) and child height for age Z-score (HAZ) as the secondary health outcome. The 2005 WHO reference standard is used to assessed maternal and child nutritional status.

Lifestyle data

A household dietary diversity questionnaire will be used to estimate the variety of foods available at home that enable mother to consume the more fulfilling fruit and vegetable as well as source of protein that could improve potentially alleviate child stunting if consumed adequately. The 24-hour dietary recall will be done in two days with one day separating them. The secondary variables measured will be total energy intake, total protein intake and total fat intake for mother. Our trained research assistants will perform the 24-hour dietary recall interviews. Prior to the interview, research assistants are trained to follow a standardized protocol, ask neutral probing questions to encourage recall of food items and taught about different methods of food preparations and brands in different cultures. Dietary data will be analyzed using Food Processor Software with database specifically consisting of Indonesian Food updated yearly by Department of Nutrition, Universitas Airlangga (UA) – Indonesia. Evaluation of the actual spending of the voucher is done by collaboration with local grocery store in recording each participant grocery shopping behavior. Maternal physical activity will be measured in total daily steps using Yamax Digiwalker SW200 Pedometers (Tokyo, Japan). Mothers will wear the pedometer for 3 consecutive days. We will use a wearing time log for mothers to ensure adequate wear time.

Psychological variables

Outcome expectations of the targeted behavior about maternal fruit and vegetables intake as well as maternal physical activity and feeding animal protein to their child will be measured using a 30-item questionnaire adapted from several sources (Anderson, Winett, & Wojcik, 2007; Wójcicki, White, & McAuley, 2009; Kim & Kim, 2015). Sedentary behavior and sitting time will be assessed using the seven days SIT-Q (Wijndaele, Bourdeaudhuij, Godino, Lynch, Griffin, Westgate, & Brage, 2014). Maternal self-efficacy to engage in physical activity will be measured using a 10-item questionnaire of barrier to self-efficacy and 8-item questionnaire on self-efficacy for performing the task. Maternal self-efficacy toward fruit consumption will be measured using a 6-item questionnaire of barrier-self efficacy and a 6-item questionnaire on performing task to consume fruit. Maternal self-efficacy towards vegetable consumption will be measured using a 8-item questionnaire of barrier-self efficacy and 8-item questionnaire on performing task in consuming vegetables. Maternal self-efficacy in serving and feeding their child with animal protein will be measured using a 10-item questionnaire of barrier-self efficacy and 15-item questionnaire on performing the task to serve and feed their child with animal protein. The self-efficacy questionnaire is developed as a Likert scale, answered based on Bandura's guide for constructing self-efficacy scales (Bandura, 2006).

Moderating variables

Moderating variables such as age, ethnicity, occupational status, educational attainment, and nutritional literacy will be collected at the baseline. Number of children, household income, and food expenditure will be obtained to estimate socioeconomic status (SES).

Process evaluation

To provide a sense of quality in the outcomes to be measured, we will conduct several measures of "process evaluation". First, we will monitor adherence to the intervention by making a log of nutrition education sessions including attendance list filled by our research assistants, in the form of biweekly goal setting sheets filled by mothers at the end of class and hands-on activity sessions. Through collaboration with a local grocery store, we will monitor maternal grocery purchases from the recorded grocery voucher that we gave to the mothers each time they attend our class and hands-on session. In addition, a log for daily steps and wear time will be recorded as a part of motivational interviewing session with the community health worker during home visit.

We will conduct a mediational analysis to examine whether changes in behavioral and psychological factors in the SCT construct (self-efficacy, outcome expectation and goal setting) mediate the association between the intervention and outcomes. Subgroup analysis will be used to examine whether the association between the intervention and the outcomes are modified by socioeconomic status (SES), and demographic measured at baseline, such as age, number of children, education status, employment, and nutritional literacy.

Statistical analysis plan

To analyze differences in the outcomes between control and intervention groups, we will use ANOVA. This statistical analysis will be adjusted for possible confounding, such as maternal characteristics, SES, and household characteristics. All data analysis will be performed in IBM SPSS Statistics 22 (Armonk, NY). In the event that, after 3 months of intervention, our study has high noncompliance or missing outcomes, we will conduct intention-to-treat (ITT) analysis.

Discussion

This study will compare the effectiveness of the NEO-MOM intervention with usual care plus printed educational materials primarily for increasing child's height and secondly for increasing child stunting and maternal overweight and obesity. The study setting is an urban population in Surabaya City, Indonesia. Maternal outcome expectation could be enhanced through the 6 series of our nutrition classes each for about an hour length. Participants in NEO-MOM group was given active mastery experience towards healthy behavior such as healthy cooking practice, healthy grocery shopping on a budget and create how to create goal setting to increase maternal self-efficacy. It is hypothesized that participants in the intervention group will benefit from verbal motivation given by community health worker during biweekly home visits to support attainment of high self-efficacy, and this approach will magnify the effect of the 6 sessions of behaviorally oriented nutrition education.

The strength of the study is that the setting includes the infrastructure for dissemination of research finding through *posyandu* and the large urban inhabitants of Surabaya City. A limitation is the fact that variation and inequalities between islands cannot be captured. As Surabaya City is the center of urbanization second only to Jakarta, however, allowing ethnicity and deprivation to be addressed in the study design.

The intervention offers the advantage of potentially active ingredients to support behavioral change, such as improved self-efficacy, biweekly goal setting and verbal motivation through home visits. We will employ triple anthropometric measurement of mother-child pairs during recruitment to reduce measurement bias. Selection bias will be reduced by random allocation of consented participants. However, some degree of selection bias might occur, as consented participants might be already motivated about the study. Due to the nature of the

intervention, blinding participants as well as research assistants delivering the intervention are not possible. Objective anthropometric measurements, blinded assessor for baseline and evaluation data collection, as well as a standardized procedure for self-reports will be applied to limit potential bias during outcome assessment.

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Chapter 7 - The Effectiveness of Nutrition Education for Overweight/Obese Mother with Stunted Children (NEO-MOM) in Reducing Double Burden of Malnutrition: Preliminary Results

Abstract

Introduction: In households experiencing double burden of malnutrition, stunted children are in a better position for growth improvement when parents are able to direct their resources to support nutrition requirements. This study assesses the effectiveness of a behavioral intervention to reduce child stunting by targeting mothers as change agents over a three-month period. Design: Randomized Controlled Trial (RCT). *Settings/participants:* Primarily pairs of overweight/obese mothers with stunted children aged 2 to 5 years old in urban Indonesia. Methods: Seventy-two mother-child pairs were randomly assigned to receive either (1) a 12-week behavioral intervention focused on healthy lifestyle behaviors or (2) printed educational materials (comparison group). *Main outcome measures:* The primary outcome was child height, and other outcomes included height-for-age z-score, maternal weight and BMI, measured at baseline and again three-months later following the intervention. Maternal self-efficacy, outcome expectations, nutrition literacy, and household dietary diversity were also assessed. A mixed factorial ANOVA was used to test for between-group differences over time. *Results:* Across group, there was a significant effect of time on child height and weight. No significant effects were observed for time on either child height or weight between-groups. A significant time-by-group interaction was observed for most of the maternal self-efficacy measures following the three-month intervention. Maternal outcome expectations in providing animal protein for the

children (*P*=0.025) and mother's total caloric intake (*P*=0.017) favored the intervention group over the comparison group. *Conclusions:* The behavioral intervention to improve child growth produced strong improvement in maternal self-efficacy to engage in physical activity, eat fruits and vegetables and to provide children with growth-promoting animal protein, but did not significantly influence child height gain.

Trial registration: This trial is registered at the Australian New Zealand Clinical Trials Registry (ANZCTR) and is allocated the registration number: ACTRN12615001243505. The Universal Trial Number (UTN) for this study is U1111-1175-5834.

Keywords: nutrition education, behavioral intervention, self-efficacy, home visit, stunting, overweight, obesity, double burden of malnutrition

Introduction

In developing countries, one fourth of children under the age of five fail to grow normally because of a condition known as stunting (World Health Organization [WHO], 2006). Child stunting is a public health nutrition problem that hinders the development of future generations. Compare their non-stunted peer, stunted children have shown to be more susceptible to gain more fat mass than lean mass in a cohort in Brazil (Martins et al., 2004). After 7 to 9 years follow up, previously stunted children at 2 years of age were significantly shorter and lighter but their BMI or centralization of body fat was not significantly different from non-stunted South African children (Cameron et al., 2005). Beyond physiological effects, stunting may limit a child's cognitive abilities and productivity (United Nations Children's Fund [UNICEF], 2013). In light of these damaging consequences, the WHO and its member countries are working to

achieve a 40% reduction in child stunting by 2025 through the Scaling-Up Nutrition (SUN) program (UNICEF, 2013).

Effective community-based interventions must be developed to ameliorate child stunting and support WHO and UNICEF programs to combat child growth problems worldwide. A systematic review of the literature to explore the impact of education and complementary feeding on growth of children under 2 years of age in developing countries showed positive results (Lassi et al., 2013). In a subgroup analysis of the food secure population, child-feeding education alone yielded a significant improvement in height gain in children under the age of 2 years (Lassi et al., 2013). A previous study in Bangladesh that assessed a 3-month nutrition education intervention along with complementary feeding showed promising results for height gain (Imdad, Yakoob, & Bhutta, 2011; Roy et al., 2005). The effect of providing complementary food and intensive nutrition education on height gain (cm) in Bangladesh was 0.80 (95%CI=0.007-1.53) (Roy et al., 2005). A systematic review of community-based nutrition education programs revealed significant results when community leaders met with caregivers twice a week in their home, to deliver nutrition education programs and cooking demonstrations (Majamanda et al., 2014).

A demographic shift in conjunction with an epidemiological and nutrition transition has created an unusual situation in which both over- and under-nutrition occur within the same population. Child stunting is a persistent feature of this problem, known as the double burden of malnutrition. A study in a Guatemalan population informed our hypothesis that in households suffering from the double burden of malnutrition, stunted children are less likely to experience food insecurity. Results of that study revealed that the prevalence of coexistence of under-nutrition (child stunting) and over-nutrition (maternal overweight/obesity) was highest (22.7%) among those in the middle (third) quintile of socioeconomic status (SES) (Lee, Houser, Must,

Fulladolsa, & Bermudez, 2012). This evidence suggests that in this socioeconomic group, relative to the others, in the absence of food insecurity and economic deprivation, modifiable factors such as food distribution and dietary diversity within the household were associated with the double burden of malnutrition. Furthermore, these households appeared to lack the capacity to direct resources properly to prevent child stunting. More specifically, we suggest that mothers were unable to make healthy food choices and manage food supply and distribution within the household.

A behavioral intervention was developed to target modifiable behaviors related to the double burden of malnutrition and to equip mothers with skills necessary to overcome these problems. The study was conducted in an urban setting in Indonesia through the Nutrition Education for Overweight/Obese Mother with Stunted Children (NEO-MOM) intervention. Drawing on concepts from Social Cognitive Theory (SCT), participants were prompted to set goals for themselves to improve their dietary habits and child feeding behaviors, with a focus on self-efficacy, nutrition literacy and dietary diversity.

This study was designed to test the hypothesis that for households facing the double burden of malnutrition in urban Indonesia, a behavioral intervention, coupled with a government food supplementation program, would be more effective than standard care combined with print educational materials for improving child outcomes for height and height-for-age z-score, maternal outcomes for weight, waist circumference, BMI, dietary diversity, dietary intake, self-efficacy, outcome expectations and nutrition literacy.

Methods

This randomized controlled trial (RCT) assessed the effectiveness of a behavioral intervention aimed at empowering mothers to address the double burden of malnutrition within the household. The intervention was based on concepts of Bandura's (1989) Social Cognitive Theory (SCT), which are briefly mentioned here. Details about the methodology and protocols can be found in chapter 6 of this dissertation. This study did not compare the effect of the intervention group (NEO-MOM group) with a true control group, but with a comparison group that received printed educational materials (PRINT group) plus government supplementation on child stunting and maternal overweight/obesity.

We collected two 24-hour dietary food recalls per mother at set times, baseline and 3 months after baseline. A portion-size guide and food models were provided to parents to assist them in estimating portion sizes. Dietary data was analyzed using NutriSurvey, a software that draws on a database containing nutrition information on typical Indonesian Food. The database is updated yearly by the Department of Nutrition, Universitas Airlangga (UA) – Indonesia.

Following the constructs of Social Cognitive Theory, we measured the mother's self-efficacy, outcome expectations and knowledge measured as nutrition literacy. We developed eight measures of maternal self-efficacy, according to Bandura's guidelines for constructing self-efficacy scales (Bandura, 2006). The Likert-scale measures ranged from 0 to 100 and covered barriers and tasks for mothers related to being physically active, to eating fruits and vegetables and providing children with animal protein in their meals. Outcome expectations were measured with series of questions for the same tasks rated on a scale from 1 to 5, with 1 representing a strong disagreement and 5 representing a strong agreement. Nutrition literacy was measured in

three domains (i.e. knowledge in the area of macronutrient, household food measures and food group categorization).

For all variables that were normally distributed or transformed to normality, we analyzed the difference in the outcome from control and intervention group using a mixed factorial ANOVA. The within-subjects variables were the outcome variables in this research, and the between-subject variable was the group of intervention (NEO-MOM and PRINT). We used the household food insecurity access scale (HFIAS) score as covariates in the analysis. Furthermore, we conducted the ANCOVA test to see the difference in changes of primary and secondary outcome adjusted for its baseline value and the HFIAS score. For nonparametric statistics, we employed the two related-samples Mann Whitney U test and analyzed the data separately for the NEO-MOM group and the PRINT group with Bonferroni correction. All data analyses were performed in IBM SPSS Statistics 22 (Armonk, NY). The statistical significance for all the tests was set at an alpha level of 0.05.

Results

Characteristics of participants and groups

Table 7.1 summarizes characteristics of the participants (household, mother and children) at baseline in the NEO-MOM and PRINT groups.

Table 7.1 Participants characteristics at baseline (n=71)

Variable	NEO-MOM (n=35)		PRINT (n=36)	
	M	(SD)	M	(SD)
Child characteristics				
Age (months)	39.57	7.82	40.24	8.11
Weight	11.32	1.92	12.25	2.44
Height (cm)	86.84	6.34	89.43	5.34
Maternal characteristics				
Age (years)	34.09	6.86	31.47	6.76
Education (years)	7.29	7.75	7.89	3.62
Weight (kg)	64.59	8.83	67.99	10.15

Height (cm)	147.43	5.11	148.23	4.67
Waist circumference	92.61	8.30	93.91	9.72
Household characteristics				
Dietary diversity	7.29	1.86	7.22	1.80
HFIAS score	8.94	5.75	5.92	5.49
Monthly Income (Rupiahs)	1,532,857	512,769	2,116,666	1,448,562
Monthly Food expenditure	974,074	343,726	1,217,307	316,418
Maternal physical activity				
Average daily step	3156	2134	2899	2356

Intervention effect on outcomes and mediators

We used the HFIAS score as covariates when testing for an intervention effect in a mixed repeated measure ANOVA.

Child's outcomes

As seen in Table 7.3 and 7.4, there were no significant effects observed in the group-by-linear-time trend interaction for any of the child health outcomes, but we observed a significant time effect for child weight (P=0.023) and child height (P=0.001).

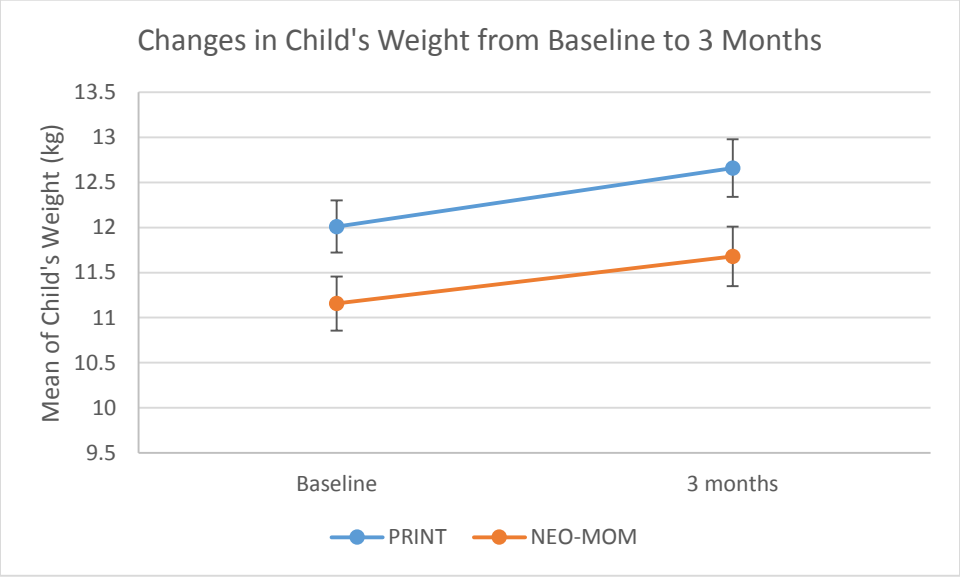

Figure 7.1 Profile plot of child's weight change from baseline to 3 months evaluation

There were significant increases in weight (P<0.001) (see Figure 7.1) and child height (P<0.001) (see Figure 7.2) for all groups in a pairwise comparison from baseline to 3-month after baseline

evaluation. The mean group difference for child height was 2.47 cm (95%CI=1.55 to 3.39) and for child weight it was 0.58 kg (95%CI=0.32 to 0.85). The ANCOVA test showed that the change in child's height and weight was not significantly different between NEO-MOM and PRINT group (*P*=0.526 and *P*=0.431 respectively).

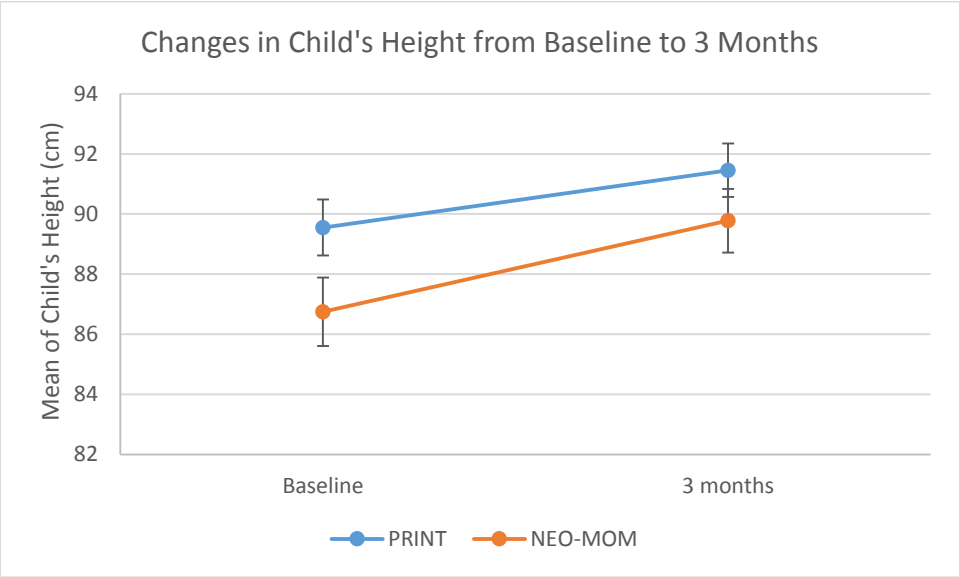

Figure 7.2 Profile plot of child's height change from baseline to 3 months evaluation

In terms of child height-for-age z-score (HAZ), the observed improved value was not statistically significant using the related-samples Mann Whitney U test for both the NEO-MOM and PRINT groups (*P*=0.183 and *P*=0.051, respectively).

Maternal outcomes

There were no significant effects in the group-by-linear-time trend interaction for maternal anthropometric outcomes such as weight, waist circumference, and the BMI (Table 7.3 and Table 7.4). Similarly, there were no significant mean group differences from baseline to 3months after the baseline evaluation for maternal weight (*P*=0.223) (see Figure 7.3), waist circumference (*P*=0.929) (see Figure 7.4), and the BMI (*P*=0.066).

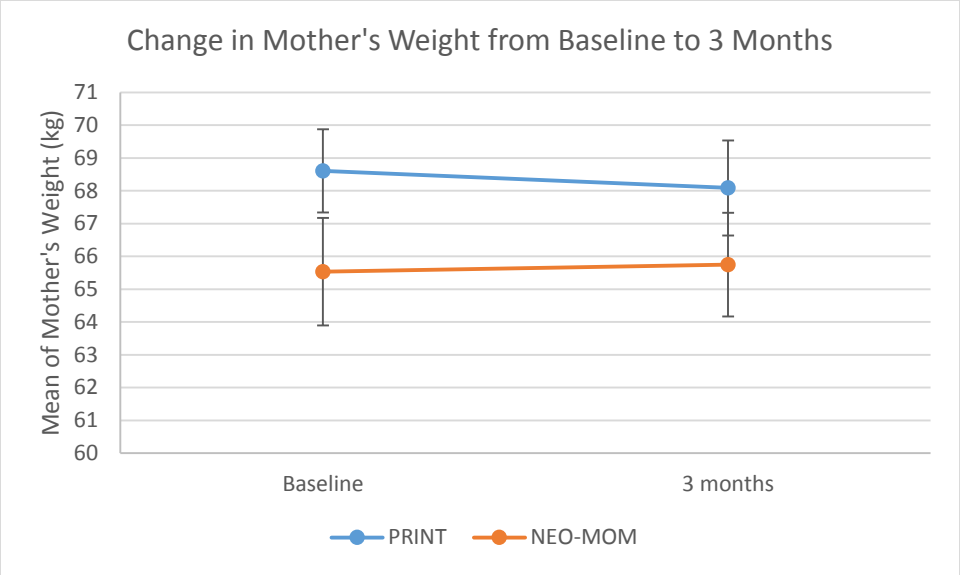

Figure 7.3 Profile plot of maternal weight change from baseline to 3 months evaluation

In this analysis, to achieve normal distribution of the data, BMI was transformed using logistic transformation. There was no significant difference in the effect of study condition for any of the maternal outcome measures (Table 7.3). In Table 7.2, after 3 months intervention, the ANCOVA test revealed that the change in mother's weight and waist circumference was not significantly different between NEO-MOM and PRINT group (*P*=0.871 and *P*=0.397 respectively).

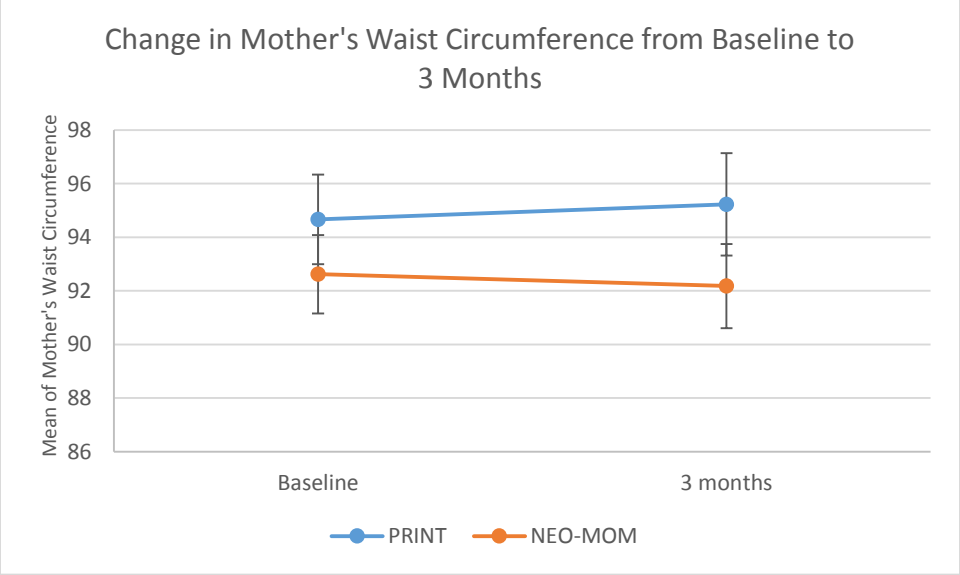

Figure 7.4 Profile plot of change in maternal waist circumference from baseline to 3 months evaluation

Household dietary diversity

The household dietary diversity score decreased for both NEO-MOM and PRINT group after the 3-month period. In the non-parametric related samples Mann Whitney U test, the results showed statistical significance at Z=-2,847 (P=0.004) and Z=-3.380 (P< 0.001). The decline in the dietary diversity score was steeper in the PRINT group (from 7.29 at baseline to 5.68 after 3 months) than in the NEO-MOM group (from 7.44 at baseline to 6.50 after the 3-month intervention).

Maternal self-efficacy

We measured maternal self-efficacy in terms of barriers and task performance of four behaviors: being physically active, eating fruit, eating vegetables and providing children with animal protein. All measures of maternal self-efficacy were having good internal consistency indicated by having Cronbach's alpha>0.65. At baseline, Cronbach's alpha obtained for maternal self-efficacy barriers for being physically active was 0.73, for eating fruit was 0.83, for eating vegetables was 0.66 and for providing animal protein was 0.91. In terms of maternal self-efficacy task, the internal consistency were also good for all measures: being physically active (Cronbach's alpha=0.93), eating fruit (Cronbach's alpha=0.74), eating vegetables (Cronbach's alpha=0.76) and providing animal protein (Cronbach's alpha=0.81). After 3 months intervention, Cronbach's alpha obtained for maternal self-efficacy barriers for being physically active was 0.86, for eating fruit was 0.87, for eating vegetables was 0.88 and for providing animal protein was 0.91. In terms of maternal self-efficacy task, the internal consistency were also good for all measures: being physically active (Cronbach's alpha=0.93), eating fruit (Cronbach's alpha=0.91), eating vegetables (Cronbach's alpha=0.90) and providing animal protein (Cronbach's alpha=0.92).

The group by time interaction on maternal self-efficacy in dealing with barriers was significant for all measures, with rates of increase being more strongly positive in the NEO-MOM group than in the PRINT group (Table 7.3). The group by time interaction on maternal self-efficacy barriers for being physically active, eating fruits, eating vegetables, and providing the child with animal protein were all statistically significant (*P*=0.030, 0.006, 0.002, and 0.042, respectively). As seen in Figure 7.5, the improvement in maternal self-efficacy barriers to provide their child with animal protein was in the right direction for the NEO-MOM group (from 60.36 at baseline to 67.24 after the 3-month evaluation) in contrast to the PRINT group, which showed a decrease (from 63.47 at baseline to 57.78 after a 3-month evaluation). There was a significant time effect for the maternal self-efficacy barrier of eating vegetables (*P*< 0.001). However, a similar time effect was not observed within subjects for the other three measures. There was no significant result in the between-subjects test.

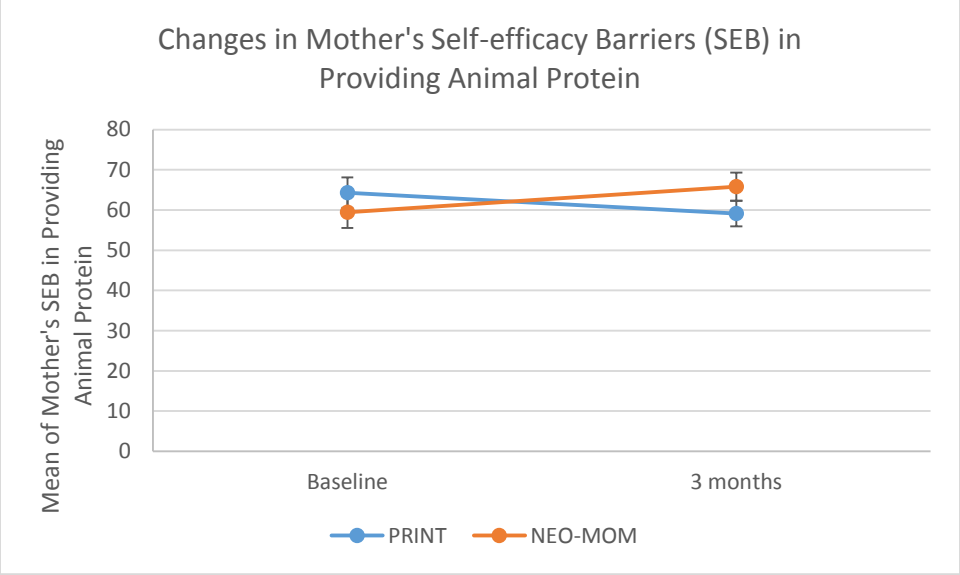

Figure 7.5 Profile plot of maternal self-efficacy (barriers) for providing animal protein

The group by linear time trend interaction effects on maternal self-efficacy to perform certain tasks was only significant for the task of eating fruit (*P*=0.043) and for the task of providing animal protein for the child (*P*=0.032). (See Figure 7.6 and Figure 7.7).

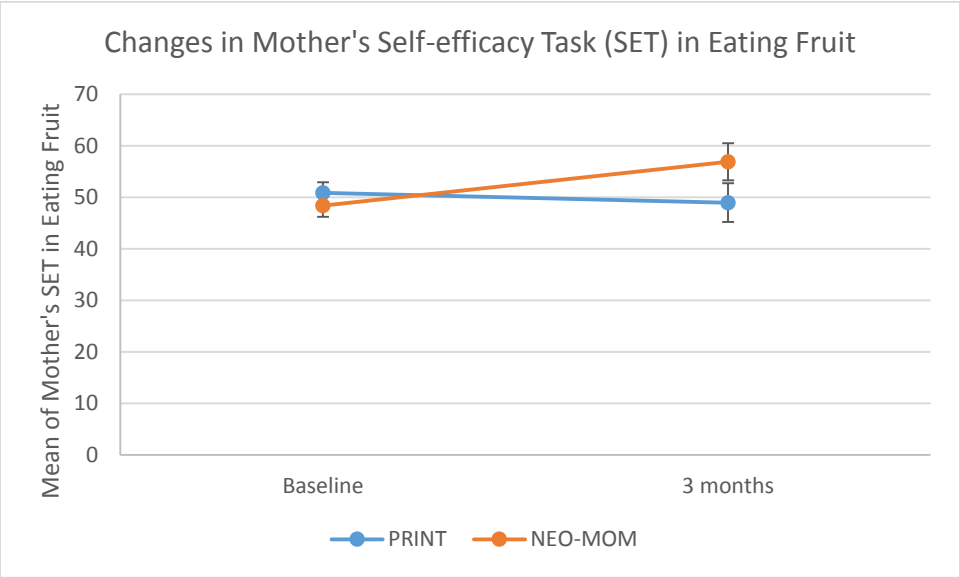

Figure 7.6 Profile plot of maternal self-efficacy (task) for eating fruit

The rate of increase in the maternal self-efficacy in the task of eating fruit was strongly positive in the intervention condition (from 49.16 at baseline to 58.19 after the 3-month evaluation) than the comparison condition, which showed a negative trend (from 50.08 at baseline to 47.66 after a 3-month evaluation).

Mother's self-efficacy (task) in providing animal protein for their children, showed a negative trend for both the NEO-MOM and PRINT group with a steeper rate of decline in the latter group (Figure 7.7). In the NEO-MOM group, maternal self-efficacy (task) for providing animal protein was 63.51 at baseline and was 63.18 after the 3-month evaluation, while in the PRINT group it declined from 64.78 at baseline to 54.20 after 3-months. There was also significant time effect for maternal self-efficacy (task) for being physically active (P<0.001). No significant between-subjects effects were revealed for any of the maternal self-efficacy tasks.

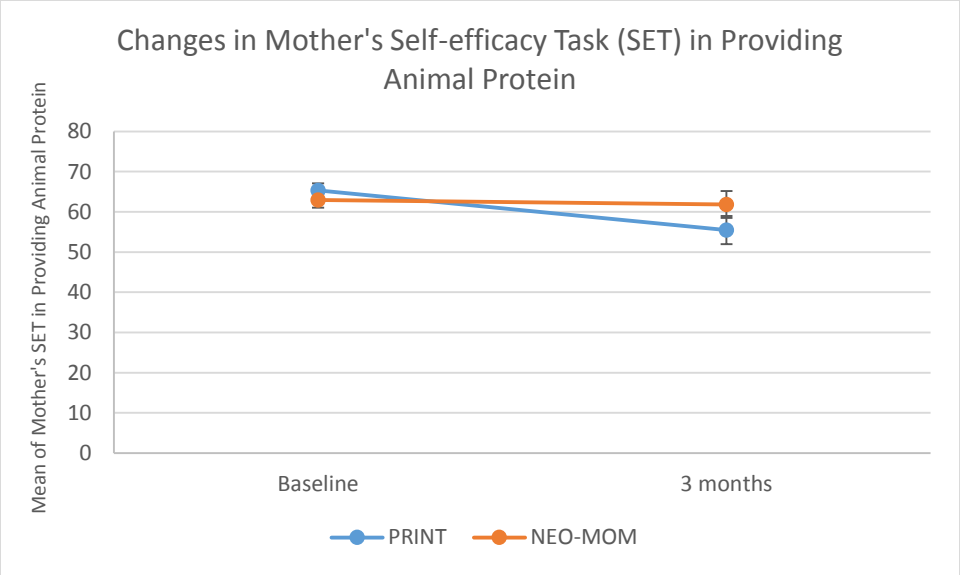

Figure 7.7 Profile plot of maternal self-efficacy (task) for providing animal protein

As seen in Table 7.2, after three months intervention, the ANCOVA test revealed that the change in mother's self-efficacy was shown to be significantly different between NEO-MOM and PRINT group especially in the barriers self-efficacy in eating fruit (*P*=0.002), barriers self-efficacy in eating vegetables (*P*=0.002), barriers self-efficacy in serving the children with animal protein (*P*=0.026), task self-efficacy in eating fruit (*P*=0.036), task self-efficacy in providing their children with animal protein (*P*=0.039).

Maternal outcome expectation

All measures of maternal outcome expectation had good internal consistency with Cronbach's alpha>0.65. At baseline, Cronbach's alpha obtained for maternal outcome expectation in engaging in physical activity was 0.86, eating fruit and vegetables was 0.76, and providing animal protein for their children was 0.84. After 3 months intervention, the internal consistency were also good for all measures of outcome expectation: being physically active (Cronbach's alpha=0.86), eating fruit and vegetables (Cronbach's alpha=0.84), providing animal protein for their kids (Cronbach's alpha=0.89). Measures of maternal outcome expectation were not normally distributed. Even though all measures showed positive increase in the NEO-MOM

group relative to the PRINT group (Table 7.4), there was only one measure, providing animal protein for the child that increased significantly in the NEO-MOM group (Z=-2.242; *P*=0.025). Maternal outcome expectation for providing the children with animal protein was increasing for both NEO-MOM group (from 5.12 at baseline to 5.33 at 3-month evaluation) and PRINT group (from 5.13 at baseline to 5.17 at 3 months) even though it was not statistically significant.

Maternal nutrition literacy

All measures of maternal nutrition literacy were not showing good internal consistency with Cronbach's alpha <0.65. At baseline, Cronbach's alpha obtained for maternal nutrition literacy for macronutrient domain was 0.56, for household food measures was 0.14, and for grouping foods according to Indonesian version of MyPlate was 0.41. After 3 months intervention, the internal consistency were also not good for all domains of nutrition literacy: macronutrient (Cronbach's alpha=0.53), household food measures (Cronbach's alpha=0.33), grouping foods (Cronbach's alpha=0.64).

Because the data for maternal literacy was not normally distributed, we employed repeated Mann Whitney test for statistical analysis. Results showed no significant effect of the intervention on the mother's nutrition literacy measures (Table 7.4). The greatest change in the nutrition literacy was observed in the NEO-MOM group for the literacy test for food group categorization test using the Indonesian version of MyPlate called "*Piring Makanku*" (*Z*=-1.442; *P*=0.149).

Maternal dietary intake

Based on the results of Mann Whitney test, almost all measures of maternal dietary intake showed no significant effect with only total energy (caloric) intake that was statistically significant in the NEO-MOM group (Table 7.4). Mother's total energy intake in the NEO-MOM

group decreased from 1,075 kcal at baseline to 845 kcal at 3 months (Z=-2.393; *P*=0.017) and declined in the PRINT group from 1,029 kcal at baseline to 840 at 3 months (Z=-1.135; *P*=0.257).

Moderation of intervention effects

For all variables that passed the normality assumption we used the household food insecurity access scale (HFIAS) score as the covariate. Our results showed that the HFIAS score was a significant moderator of some of the significant outcome variables measures. Treated as a covariate in the mixed method ANOVA analysis, the HFIAS score revealed significant between-subjects effects for maternal self-efficacy (barriers) in providing children with animal protein (F(1, 64)=5.534, *P*=0.022), self-efficacy (task) in eating fruit (F(1, 64)=4.943, *P*=0.030), self-efficacy (task) in eating vegetables (F(1, 64)=4.781, *P*=0.033), and self-efficacy (task) in providing their child with animal protein (F(1, 64)=6.802, *P*=0.011).

Table 7.2 The ANCOVA test results on primary outcomes & maternal self-efficacy (n=66)

Variable	F	*P*	Partial eta squared	Adjusted R squared
Child's outcomes				
Weight (kg)	0.629	0.431	0.010	0.151
Height (cm)	0.407	0.526	0.007	-0.022
Maternal outcomes				
Weight (kg)	0.027	0.871	0.000	-0.028
Waist circumference (mm)	0.726	0.397	0.012	-0.025
BMI[a]	0.115	0.736	0.002	-0.023
Maternal self-efficacy (Barrier)				
Being physically active	2.035	0.159	0.032	0.323
Eating fruit	10.011	0.002*	0.139	0.404
Eating vegetables	10.238	0.002*	0.142	0.236
Providing animal protein for kids	5.224	0.026*	0.078	0.474
Maternal self-efficacy (Task)				
Being physically active	3.922	0.052	0.059	0.276
Eating fruit	4.624	0.036*	0.070	0.096
Eating vegetables	3.137	0.081	0.048	0.179
Providing animal protein for kids	4.468	0.039*	0.067	0.081

Note. Significance based on α=0.05; ****P*<0.001, ***P*<0.01, **P*<0.05. [a]The analysis is based on log-transformed variable

Table 7.3 Group means and test of within- and between- subject effect (n=66)

Outcome/Mediator	Mean (SE)				Test of Within-Subject Effect		Test of Between-Subject Effect
	Intervention (n=32)		Comparison (n=34)		Partial Eta Square (*P*)		
	Baseline	3 Month	Baseline	3 Month	Time	Time by Group Interaction	Group Difference
Child's outcomes							
Weight (kg)	11.19 (0.31)	11.69 (0.34)	11.98 (0.29)	12.64 (0.33)	0.080 (0.023)*	0.005 (0.578)	0.059 (0.050)*
Height (cm)	86.80 (1.07)	89.90 (1.01)	89.49 (1.04)	91.34 (0.98)	0.173 (0.001)**	0.027 (0.189)	0.034 (0.143)
Maternal outcomes							
Weight (kg)	65.17 (1.49)	64.87 (1.54)	68.35 (1.44)	67.91 (1.49)	0.034 (0.139)	0.001 (0.819)	0.033 (0.146)
Waist circumference (mm)	92.18 (1.60)	91.73 (1.80)	95.08 (1.56)	95.67 (1.74)	0.000 (0.992)	0.008 (0.505)	0.034 (0.141)
BMI[a]	30.13 (0.62)	29.95 (0.59)	31.01 (0.66)	30.63 (0.75)	0.054 (0.062)	0.006 (0.543)	0.022 (0.235)
Maternal self-efficacy (Barrier)							
Being physically active	43.95 (2.61)	49.11 (2.88)	50.55 (2.53)	45.34 (2.79)	0.008 (0.472)	0.072 (0.030)*	0.003 (0.650)
Eating fruit	53.04 (3.80)	62.49 (3.41)	55.66 (3.69)	49.82 (3.30)	0.025 (0.207)	0.115 (0.006)*	0.021 (0.251)
Eating vegetables	35.29 (2.62)	61.13 (3.39)	38.03 (2.54)	48.54 (3.28)	0.376 (<0.001)***	0.146 (0.002)**	0.029 (0.174)
Providing animal protein for kids	60.36 (3.95)	67.24 (3.31)	63.47 (3.83)	57.78 (3.21)	0.008 (0.491)	0.064 (0.042)*	0.009 (0.448)
Maternal self-efficacy (Task)							
Being physically active	34.71 (3.99)	56.19 (4.17)	30.53 (3.86)	43.62 (4.04)	0.203 (<0.001)***	0.026 (0.199)	0.047 (0.083)
Eating fruit	49.16 (2.12)	58.19 (3.73)	50.08 (2.09)	47.66 (3.67)	0.028 (0.185)	0.071 (0.034)*	0.031 (0.167)
Eating vegetables	55.17 (2.19)	58.57 (3.48)	55.30 (2.12)	49.98 (3.38)	0.014 (0.355)	0.041 (0.105)	0.028 (0.182)
Providing animal protein for kids	63.51 (1.83)	63.18 (3.42)	64.78 (1.78)	54.20 (3.32)	0.002 (0.717)	0.071 (0.032)*	0.024 (0.217)

Note. Significance based on α=0.05; ****P*<0.001, ***P*<0.01, **P*<0.05. [a]The analysis is based on log-transformed variable

Table 7.4 Group means and differences between group means for all outcomes in non-parametric statistics (n=66)

Outcome/Mediator	Intervention				Comparison			
	Mean (SD)		Z	*P*	Mean (SD)		Z	*P*
	Baseline (n=32)	3 Month (n=32)			Baseline (n=34)	3 Month (n=34)		
Child's HAZ	-2.99 (0.85)	-2.85 (0.79)	-1.333	0.183	-2.67 (0.57)	-2.55 (0.61)	-1.951	0.051
Mother's BMI	30.13 (3.52)	29.95 (3.34)	-0.895	0.371	31.01 (3.84)	30.63 (4.36)	-1.646	0.100
Household dietary diversity	7.44 (1.70)	6.50 (2.11)	-2.847	0.004	7.29 (1.75)	5.68 (1.61)	-3.380	<0.001
Maternal outcome expectation								
Being physically active	5.04 (0.65)	5.21 (0.48)	-1.381	0.167	5.01 (0.72)	4.86 (0.72)	-1.082	0.279
Eating fruit & vegetables	5.06 (0.56)	5.18 (0.49)	-1.312	0.190	4.98 (0.54)	4.97 (0.57)	-0.152	0.879
Providing animal protein for kids	5.12 (0.54)	5.33 (0.48)	-2.242	0.025	5.13 (0.59)	5.17 (0.56)	-0.320	0.749
Maternal nutrition literacy								
Macronutrient	2.63 (1.62)	2.47 (1.48)	-0.630	0.529	3.15 (1.50)	3.03 (1.62)	-0.367	0.714
Household food measures	1.78 (1.01)	1.75 (0.76)	-0.339	0.735	1.53 (1.11)	1.32 (0.98)	-0.920	0.358
MyPlate categorization	12.72 (1.78)	13.19 (2.39)	-1.442	0.149	12.79 (1.90)	12.82 (1.96)	-0.039	0.969
Maternal dietary intake								
Energy	1075 (538)	845 (559)	-2.393	0.017	1029 (774)	840 (502)	-1.135	0.257
Protein	57.29 (42.11)	44.69 (39.59)	-1.627	0.104	46.50 (38.99)	39.28 (32.47)	-1.027	0.304
Fat	49.95 (51.99)	37.82 (48.80)	-1.646	0.100	56.21 (62.00)	43.29 (48.23)	-0.652	0.514
Carbohydrate	103.18 (74.50)	90.75 (69.79)	-0.926	0.355	91.71 (59.06)	77.71 (39.49)	-1.349	0.177
Iron	6.62 (8.04)	6.58 (11.54)	-1.197	0.231	6.32 (7.69)	5.22 (3.40)	-0.527	0.598
Zinc	3.93 (2.13)	3.18 (2.27)	-1.833	0.067	3.62 (2.51)	3.35 (1.89)	-0.225	0.822
Calcium	140.17 (96.21)	144.31 (200.88)	-1.141	0.254	157.05 (190.80)	159.81 (186.58)	-0.527	0.698
Vitamin A	842 (559)	680 (1466)	-1.496	0.135	982 (2441)	503 (738)	-1.930	0.054
Fiber	6.77 (7.29)	6.75 (10.60)	-1.029	0.303	8.47 (14.88)	5.45 (5.22)	-1.524	0.127

Note. The test was based on repeated measures non-parametric statistic of Mann Whitney U.

Discussion

The goal of this study was to empower and equip overweight or obese mothers to overcome the double burden of malnutrition. Mothers received training on strategies in overcoming the double burden of malnutrition. They were trained through behavioral strategies such as mastery experience, vicarious experience, goal setting and verbal motivation to achieve better health outcomes for themselves, as well as for their children. The hypothesis of this randomized controlled trial was that applying behavioral intervention strategies based on Bandura's Social Cognitive Theory for 3 months would be effective in improving child growth to address the issue of child stunting in a household facing the double burden of malnutrition. Results revealed that after a 3-month intervention there was a positive increase in child height in both groups. However, the lack of significance in the time and group interactions as well as the test of the between-subjects effect indicated that the significant time effect observed could well be attributable to the natural growth of the child and not the intervention.

Another possible explanation for the observed results might be related to the compliance of the mothers in implementing the Indonesian government food supplementation program for the underweight children. Compared to the previous study in Bangladesh that included food supplementation as a part of the intervention (Imdad et al., 2011; Roy et al., 2005), in our study we relied on the food supplementation part from the government program and use it as an inclusion criteria for eligible participants. Hence, the amount of effort in ensuring participant's compliance in the use of food supplementation in the Bangladeshi study was likely to be more rigorous than this one. But, because we did not measure the compliance rate related to the consumption of food supplementation from the government, a comparison with previous study in Bangladesh was not possible.

Furthermore, children 2 to 5 years old have passed the optimum time for rapid linear growth that occurs during the first 1,000 days of life. However, stunted children in this age range needed an intervention to catch up with their normal peers. In terms of the height-for-age z-score (HAZ) measure, we did not find a significant effect in both the intervention and comparison group. The fact that our intervention targeted children from the age of 24 months to less than 5 years old might have hindered the effect in comparison to one targeting children during the first 1,000 days of life or from the womb up to 24 months old when they have the best opportunity for growth improvement. Results of a meta-analysis on interventions aimed at improving child nutritional status revealed that interventions were generally more effective for children under the age of 2 years, and for those who were nutritionally deprived (Kristjansson et al., 2015).

We saw a significant increase in child's weight overtime for both group (P=0.023), and there was borderline significant difference in the weight change from baseline between intervention and comparison group (P=0.050). While for child's height, no significant difference was observed between the effect of intervention and comparison condition (P=0.143). This supports a previous study in a developing country that reported greater effect size in increasing a child's weight than in improving a child's linear growth (Imdad et al., 2011).

All of the maternal primary outcome measures showed no significant improvement after a 3-month intervention for both groups. For anthropometric outcomes such as weight, waist circumference and BMI it might take longer for the intervention to have significant effects. The length of time employed in the current study was calculated based on the time needed to improve child's height from a previous study and was not based on the maternal anthropometric measures. Therefore, the lack of significant effects in our study for maternal primary outcomes might be due to the insufficient length of the intervention.

However, we saw significant improvement on almost all measures of maternal self-efficacy for both tasks and barriers. There was significant increase for all four maternal self-efficacy (barriers) and two of the maternal self-efficacy (tasks) overtime. This result aligned with a study in Australia that showed maternal self-efficacy was a good predictor for the quality of diet among children aged 3 to 5 years (Collins et al., 2016). Mother's child feeding behavior was indirectly related to child vegetable intake through maternal feeding self-efficacy in an Australian population (Koh et al., 2014). Results from qualitative studies also support the importance of self-efficacy in influencing healthy eating decision-making (Kilanofski, 2015) and food preparation behavior (Smith et al., 2016). Even though we did not directly measure mother's behavior towards child feeding practices, we found significant effect of the intervention for both NEO-MOM and PRINT group in household's dietary diversity as an indirect measure of maternal healthy food choice behavior.

We measured behavior in terms of dietary diversity as an indication of healthy food choice in the household. The results revealed a significant effect but in a negative direction. After the 3-month intervention, the average household dietary diversity score significantly decreased for both the NEO-MOM group and comparison group. This may have been affected by the time the interview was conducted between baseline and the 3- month evaluation. Baseline data were collected at the beginning of the month, while the evaluation data was collected at the end of the month. Results may have been influenced by food budget availability and the fact that most Indonesian people receive their salary at the beginning of the month and may have had more money to spend on food at that time, as compared to the end of the month (Wolfe, Frongillo, & Valois, 2003).

The effect of our intervention on maternal dietary intake was significant only for total energy (caloric) intake in the intervention group. These results align with previous RCTs on weight loss that suggest that as the first step in trying to lose weight, women tend to reduce their caloric intake. Other nutrient intake did not show significant results, perhaps because our two times in 24 hours dietary recall may not have been sufficient to capture the variability of micronutrient intake as compared to total energy (Gibson, 2005).

There was no significant effect revealed in the three domains of maternal nutrition literacy used in this study. These results might be related to the fact that our intervention was designed based on the behavioral strategies that followed the tenets of Social Cognitive Theory. Even though we provided 6 weeks (over 600 hours) of nutrition education classes to improve mothers' knowledge, the content might not necessarily fit with the questions included in the validated nutrition literacy questionnaire (Gibbs & Chapman-Novakofski, 2013). The tools for nutrition literacy developed in the more highly educated settings in the U.S. might be too difficult to for mothers with less education in developing countries such as Indonesia. Moreover, with all three domains of maternal nutrition literacy showing Cronbach's alpha of less than 0.65, the adapted tools for measuring nutrition literacy was deemed to be having low reliability (Vaske, 2008) in urban Indonesian setting.

Strengths and limitation

To the best of our knowledge, this study was the first to conduct a randomized controlled trial (RCT) on households experiencing the problem of double burden of malnutrition in the form of coexistence of stunted children and overweight/obese mother pairs (SCOWT). The strength of the study was a solid methodological approach and RCT design, small attrition rate and the high

participation from local community health workers to deliver the intervention that promote adoption of our strategies. With limited resources, we could not incorporate supplementary feeding as part of our intervention, but we made use of the Indonesian government's 3-month supplementary feeding program to overcome severely underweight children as inclusion criteria. Therefore, a limitation of the study was the absence of a true control group. Without it, it is impossible to know whether the observed time effect was significantly different from natural growth following the age increase. For this reason, we may have underestimated the effect of print educational materials and ongoing food supplementation by the Indonesian government. Our observed effect could have been higher if we did not use the HFIAS score (measure of food insecurity) as covariates in the analysis. Application of our results is limited to an urban population in a developing country setting.

Conclusion

In conclusion, both of our interventions (NEO-MOM and PRINT) significantly increased child's growth overtime but failed to improve maternal nutritional status. Relative to the PRINT comparison group, our intervention improved almost all maternal self-efficacy measures, which are viewed as necessary steps for engaging in healthy behaviors. This study was well received by participants and may be adopted by the local community health workers who made home visits to motivate mothers during the 3-month intervention period. This study provides a basis for potential strategies to reduce the rate of child stunting in households undergoing double burden of malnutrition.

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Chapter 8 - Summary and Conclusion

In this final chapter, we review major findings of all three studies along with practical implications for policy makers and health professionals, community health workers and researchers. We also suggest topics for future research and discuss limitations of the studies in this dissertation.

Summary of Research

Throughout the studies reported in this dissertation, common themes emerged related to the problem of child stunting. Food insecurity and dietary diversity were lacking in households with children under the age of 5 who were stunted. Food insecurity was less severe in households with stunted child and overweight/obese mother pairs (SCOWT) as compared to households only experiencing the problem of child stunting. We reviewed evidence showing the double burden of malnutrition as a public health nutrition problem (Popkin, 1994) and examined correlates at all levels of the Socio Ecological Model (SEM) (Brofenbrenner, 1977). We argued that mothers play a critical role in eradicating child stunting and positive outcomes could be achieved by boosting self-efficacy of mothers to engage in healthy behaviors to maintain normal body mass index (BMI) for themselves and feed children properly by providing adequate foods rich in growth-promoting nutrients such as animal protein. Mothers in developing countries were consistently shown to be lacking in the knowledge and behaviors necessary to protect themselves and their children from the double burden of malnutrition.

We conducted a review of literature to assess current knowledge on this topic and to determine correlates, or factors associated with the double burden of malnutrition. Guided by the

framework of the Socio Ecological Model we gathered existing evidence and narrated it to depict the interrelation among correlates. This review highlighted several key points: the importance of holistic approach in overcoming double burden of malnutrition, acknowledging the complexity of the problem, and exploring it at the individual, interpersonal, community and policy level.

In the first study, we analyzed the correlation between dietary diversity and child stunting by looking at secondary data from various regions in East Java Province in Indonesia. We found a negative correlation between dietary diversity and child stunting, in other words, the greater the dietary diversity within the household the less likely it was for the household to have a stunted child. Results add to the body of evidence that suggest that child stunting is strongly associated with dietary diversity in the household.

This study about dietary diversity only looked at child stunting. In the second study we examined dietary diversity along with food insecurity and nutrition literacy in households with various combinations of mother-child pairs categorized by nutritional status. Stunted children typically lived in households with food insecurity that were lacking in dietary diversity and had mothers with a low level of nutrition literacy. In households where child stunting was the only problem the degree of food insecurity was mild compared to households experiencing the double burden of malnutrition. Severe food insecurity was a significant predictor for a household having child stunting as the only problem. Mild food insecurity was a significant predictor of the coexistence of child stunting and maternal overweight/obesity in the same household. Our findings led to the hypothesis that households with double burden of malnutrition lack the capacity to direct resources properly to prevent child stunting. Most notably, we attribute this to the mother's inability to make healthy food choices and manage food availability and distribution within the household.

We tested a behavioral intervention to empower mothers to overcome the double burden of malnutrition. The intervention, which is based on the Social Cognitive Theory (Bandura, 1989), assists participants in self-administered goal setting to improve diet and child-feeding behavior by means of improved self-efficacy, nutrition literacy and dietary diversity. Following the 3-month intervention a positive increase in child height and weight over time was observed for both behavioral intervention conditions: nutrition education accompanied by motivational interviewing techniques (NEO-MOM group) and the group receiving print educational materials with strategies for dealing with the double burden of malnutrition (PRINT group). The intervention yielded significant improvements in most of the maternal self-efficacy measures including overcoming barriers and tasks for being physically active, eating fruit and vegetables, as well as providing their children with animal protein. These results suggest potential strategies to encourage mothers to engage in healthy behaviors for themselves and to fulfill children's dietary needs for proper growth.

Limitations

The attrition rate in the randomized control trial (RCT) with behavioral intervention was only 8.3%, but we did not have control over participant's behavior toward the use of the Indonesian government supplementary feeding program. Due to limited budget and availability of a validated instrument (i.e., length-board to measure children who are not yet able to stand) we did not extend the study to children aged 6 to 24 months who might have been more responsive to our intervention. Our RCT included children ages 2 to 5 years old due to availability of validated measure for height (stadiometer). A major limitation of the first study that used the secondary data was that data had been gathered prior to our analysis. Hence, data quality was dependent on rigor of collection and management procedures used by the previous

researchers. In all three studies, measurement of dietary diversity, food insecurity and dietary intake was based on the participant's memory, with a potential for recall bias. In addition, this series of studies was conducted in Indonesia, with two studies taking place in an urban setting. Therefore, results may not be generalized beyond the urban setting or the Indonesian jurisdiction.

Implications and Future Research

Taken together, these studies showed that when resources in households undergoing the double burden of malnutrition are not utilized properly, mothers might be able to improve the growth of stunted children by bolstering self-efficacy to choose healthy foods and to improve child-feeding behaviors. These studies send a message to policy makers in developing countries. Although mothers lack nutrition literacy and the ability to choose foods affect both maternal and child food intake, Simple efforts to encourage healthy food choices and introduce proper child feeding techniques and can boost a mother's self-efficacy to engage in appropriate behaviors and improve child nutrition.

Collaboration with local community health workers has proved effective for follow-up home visits to review progress, discuss barriers, and provide mothers with encouragement and support via the motivational interviewing strategy. Wider adoption of this approach could enhance the capacity of community health workers to deliver research-based, tailored public health nutrition messages in the future.

In future research, we recommend shifting the target of the intervention to address the double burden of malnutrition to households with children aged 6 to 24 months. There is a golden opportunity to reverse stunted growth at this stage of development. In addition to behavioral intervention strategies, food supplementation should be incorporated so both factors

can be controlled. A true control instead of a comparison condition could be considered, but only if deemed to be ethical by the Institutional Review Board.

Conclusion

Double burden of malnutrition is a real public health nutrition problem in many developing countries. Peer-reviewed evidence has been dominated by correlates of double burden of malnutrition, derived from secondary data analysis and cross sectional studies. Some of the correlates that specifically reported statistical significance are maternal characteristics such as short stature, level of education, occupational status; breastfeeding status, number of children, family size, being indigenous people, dietary diversity, and living in urban area. Using a socio-ecological model to describe the complexity of double burden of malnutrition, there are potentially modifiable correlates that we tried to change in our intervention. We tried behaviorally based intervention to impact the double burden of malnutrition, specifically to improve children's growth and height-for-age z-score (HAZ) as well as to decrease maternal weight and reduce their BMI. Our study did not impact the primary outcomes, but significantly improved maternal self-efficacy as potential mediators for necessary behaviors to combat double burden of malnutrition in the form of stunted child and overweight/obese mother (SCOWT). We encourage future research to focus on addressing the double burden of malnutrition to households with children aged 6 to 24 months along with inclusion of true control group to provide a more clear depiction of effectiveness.

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Appendix A - Institutional Review Board Approval Letter for the Dietary Diversity and Child Stunting Study

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Richard Rosenkranz
Human Nutrition
201 Justin

Proposal Number: 7955

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 10/26/2015

RE: Proposal Entitled, "Household dietary diversity and child stunting in East Java, Indonesia"

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §46.101, paragraph b, category: 4, subsection:** .

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

203 Fairchild Hall, Lower Mezzanine, 1601 Vattier St., Manhattan, KS 66506-1103 | 785-532-3224 | fax: 785-532-3278 | k-state.edu/research/comply | comply@ksu.edu

Appendix B - Institutional Review Board Approval Letter for the Cross-Sectional Study

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Richard Rosenkranz
Human Nutrition
201 Justin

Proposal Number: 7646

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 04/01/2015

RE: Approval of Proposal Entitled, "Dietary diversity, food security and maternal physical activity in households with and without double burden of malnutrition."

The Committee on Research Involving Human Subjects has reviewed your proposal and has granted full approval. This proposal is **approved for one year from the date of this correspondence, pending "continuing review."**

APPROVAL DATE: 04/01/2015

EXPIRATION DATE: 04/01/2016

Several months prior to the expiration date listed, the IRB will solicit information from you for federally mandated "**continuing review" of the research**. Based on the review, the IRB may approve the activity for another year. **If continuing IRB approval is not granted, or the IRB fails to perform the continuing review before the expiration date noted above, the project will expire and the activity involving human subjects must be terminated on that date. Consequently, it is critical that you are responsive to the IRB request for information for continuing review if you want your project to continue.**

In giving its approval, the Committee has determined that:

☒ There is no more than minimal risk to the subjects.
☐ There is greater than minimal risk to the subjects.

This approval applies only to the proposal currently on file as written. Any change or modification affecting human subjects must be approved by the IRB prior to implementation. All approved proposals are subject to continuing review at least annually, which may include the examination of records connected with the project. Announced post-approval monitoring may be performed during the course of this approval period by URCO staff. Injuries, unanticipated problems or adverse events involving risk to subjects or to others must be reported immediately to the Chair of the IRB and / or the URCO.

203 Fairchild Hall, Lower Mezzanine, Manhattan, KS 66506-1103 | 785-532-3224 | fax: 785-532-3278 | k-state.edu/research/comply | comply@ksu.edu

Appendix C - Informed Consent for the Cross-Sectional Study

KANSAS STATE UNIVERSITY

INFORMED CONSENT

PROJECT TITLE:	**Dietary diversity, food security and maternal physical activity in households with and without double burden of malnutrition**
APPROVAL DATE OF PROJECT: ____	**EXPIRATION DATE OF PROJECT:** ____
PRINCIPAL INVESTIGATOR: **CO-INVESTIGATOR(S):**	**Dr. Richard Rosenkranz** **Trias Mahmudiono** **Dini Ririn Andrias** **Triska Susila Nindya** **Hario Megatsari**
CONTACT AND PHONE FOR ANY PROBLEMS/QUESTIONS:	**+1 785-532-0152 (USA);** **+62 31 5964808**
IRB CHAIR CONTACT/PHONE INFORMATION:	**Jerry Jaax/ + 1 785-532-5110**
SPONSOR OF PROJECT:	**None**
PURPOSE OF THE RESEARCH:	**The purpose of this study is to assess difference in dietary diversity, food security and physical activity of mothers in households with and without double burden of malnutrition. The results will be used to develop a behavioral intervention to reduce child stunting in households with double burden of malnutrition.**
PROCEDURES OR METHODS TO BE USED:	**This is a survey using structured questionnaire. Data collection also include measurement of maternal height, weight and waist circumfence; and also child's height/length, and weight assesed in light clothing.**
ALTERNATIVE PROCEDURES OR TREATMENTS, IF ANY, THAT MIGHT BE ADVANTAGEOUS TO SUBJECT:	
None	
LENGTH OF STUDY:	**30 minutes**
RISKS ANTICIPATED:	**There is potential for embarrassment or sensitivity regarding measurement of weight, waist circumference, and reporting of dietary diversity, food security and physical activity habits.**
BENEFITS ANTICIPATED:	**At the conclusion of the project, mother will obtain their own and their child's anthropometric measurement information related to the study. Mother may benefit from their information on dietary diversity, food security and physical activity. Participants will receive a small gift in the form of soap or toothpaste worth $0.50 for their time**
EXTENT OF CONFIDENTIALITY:	**We will have a code number for the questionnaire that will be used in data management and will keep participant identity confidential.**
IS COMPENSATION OR MEDICAL TREATMENT AVAILABLE IF INJURY OCCURS:	**No**

PARENTAL APPROVAL FOR MINORS: Yes

TERMS OF PARTICIPATION: I understand this project is research, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

(Remember that it is a requirement for the P.I. to maintain a signed and dated copy of the same consent form signed and kept by the participant)

Participant Name: _____

Participant Signature: _____ Date: _____

Witness to Signature: (project staff) _____ Date: _____

Appendix D - Questionnaire for the Cross-Sectional Study

RESPONDENT IDENTIFICATION			CODING
IRT 1	Sub-district		
IRT 2	Village		
IRT 3	Sub-village		[ ]
IRT 4	Community Health Post "Posyandu"		[ ]
IRT 5	Number		[ ]
IRT 6	Head of household		
IRT 7	Address		

INTERVIEWER IDENTITY			
IP 1	Name of the interviewer		
IP 2	Code for the interviewer		
IP 3	Date of interview		
IP 4	Time of interview	Time started:	Time ended:

INTERVIEW WAS CHECKED BY:			
Status	**Name**	**Date**	**Signature**
Interviewer			
Supervisor			
Data entry			

A. SUBJECT IDENTITY			CODING
A 1	Maternal age	…….. year	
A 2	Do you (mother) currently pregnant?	1)Yes 2)No	[ ]
A 3	Child's age	…….. month	
	Child's date of birth	day ...../ month ...../ year	
A 4	Child's sex	1. Male 2. Female	[ ]

B. MEASUREMENT			CODING
B 1	Maternal weight	1) .....kg 2)..... kg 3)..... kg Average ……..kg	
B 2	Maternal height	1) .....cm 2)..... cm 3)..... cm Average ……..cm	
B 3	Maternal Waist Circumference	1) .....cm 2)..... cm 3)..... cm Average ……..cm	
B 4	Child's weight	1) .....kg 2)..... kg 3)..... kg Average ……..kg	
B 5	Child's height	1) ..... cm 2)..... cm 3)..... cm Average ……..cm	
B 6	Child's length	1) ..... cm 2)..... cm 3)..... cm Average ……..cm	

C. SOCIAL ECONOMIC STATUS				CODING
C 1	How many children do you have?	……		[ ]
C 2	How many <5 years old children do you have?	.....		[ ]
C 3	Household type	1. Nuclear family 2. Extended family		[ ]
C 4	I want you to read these words: *(show the title of the questionnaire and asked them to read it)*	1. Unable to read at all 2. Read some of it/struggle 3. Read fluently		[ ]
C 5	What is mother's education?	1. None 2. Not finish elementary school 3. Finish elementary school 4. Finish junior high school (9 grade)	5. Finish high school (12 grade) 6. Diploma 7. Undergraduate 8. Religious education 9. Others	[ ]
C 6	What is father education?			[ ]
C 7	What is mother's job?	1. Housewife without nanny 2. Government employee 3. Private sector employee 4. Police or Military 5. Trading or entrepreneur 6. Farmer (land owner) 7. Farm worker	8. Service sector worker 9. Fisherman (boat owner) 10. Fisherman worker 11. Industry labor 12. Housewife with nanny 13. Others	[ ]
C 8	What is father's job?			[ ]
C 9	How much is your household average income?	.....rupiah *(asked with open ended question first, then proceed to choice if they are not answering)*		[ ]
C 10	How much is the average of household food expenses per month?	1. Less than Rp. 500,000,- (< US$ 50) 2. Rp. 500,000 to Rp. 1,000,000 (US$ 50 to US$100) 3. > Rp. 1,000,000 to Rp. 1.500.000 (> US$ 100 to US$ 150) 4. > Rp. 1,500,000 to Rp. 2,000,000 (> US$ 150 to US$ 200) 5. > Rp. 2,000,000 to Rp. 2,500,000 (> US$ 200 to US$ 250) 6. > Rp. 2,500,000 to Rp. 3,000,000 (> US$ 250 to US$ 300) 7. More than Rp. 3,000,000 (> US$ 300)		[ ]
C 11	Do you have this item in your house? *(Read the choice)*	1. Electricity 2. Radio/Tape 3. Television 4. Phone/Hand phone 5. Fridge 6. Computer/laptop 7. Internet	1)Yes 2)No 1)Yes 2)No 1)Yes 2)No 1)Yes 2)No 1)Yes 2)No 1)Yes 2)No 1)Yes 2)No	[ ] [ ] [ ] [ ] [ ] [ ] [ ]
C 12	If you suddenly found Rp.100,000 (US$ 10), what the first thing that you would like to do?	1. Buy food for the family 2. Buy milk for the child 3. Buy cosmetics 4. Buy new clothes	5. Buy cigarettes for the husband 5. Refill the hand phone credit 6. Others	[ ]
C 13	Do you have any disability that hinders	1)Yes 2)No		[ ]

	your ability to walk for 10 minutes continuously?		
C 14	Does your husband smoke?	1)Yes 2)No *(Proceed to question C 20)*	[ ]
C 15	Do you know how much money your husband spends for smoking?	1)Yes 2)No*(Proceed to question C 20)*	[ ]
C 16	How much is the average monthly expenses your husband use to buy cigarettes?	.....rupiah *(asked with open ended question first, then proceed to choice if they are not answering)* 1. Less than US$ 5 2. > US$ 5 to US$ 10 3. > US$ 10 to US$ 15 4. >US$ 15 to US$ 20 5. > US$ 20 to US$ 25 6. > US$ 25 to US$ 30 7. More than US$ 30 99. Don't know	[ ]
C 17	If you or your husband has a hand phone, how much in average you spend to buy credit per month?		[ ]
C 18	Did you or your husband use the hand phone mostly for business related matter?	1)Yes 2)No	[ ]

D. DIETARY DIVERSITY QUESTIONNAIRE

Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.
(Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned.)

Breakfast	Snack	Lunch	Snack	Dinner	Snack

E. FOOD GROUP			
(When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.)			
Question number	***Food Group***	***Example***	***YES=1 NO=0***
E 1	*Cereals*	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, nshima, porridge or paste	[ ]
E 2	*White Roots and Tubers*	White potatoes, White yam, White cassava, or other foods made from roots	[ ]
E 3	*Vitamin A Rich Vegetables and Tubers*	Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper)	[ ]
E 4	*Dark Green Leafy Vegetables*	Dark Green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach	[ ]
E 5	*Other Vegetables*	Other vegetables (e.g. tomato, onion, eggplant) + other locally available vegetables	[ ]
E 6	*Vitamin A Rich Fruit*	Ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits	[ ]
E 7	*Other Fruits*	Other fruits, including wild fruits and 100% fruit juice made from these	[ ]
E 8	*Organ Meat*	Liver, kidney, heart or other organ meats or blood-based foods	[ ]
E 9	*Flesh Meats*	Beef, pork, lamb, goat, rabbit, chicken, duck, other birds, insects	[ ]
E 10	*Eggs*	Eggs from chicken, duck, guinea fowl or any other egg	[ ]
E 11	*Fish and Seafood*	Fresh or dried fish or shellfish	[ ]
E 12	*Legumes, Nuts and Seeds*	Dried beans, dried peas, lentils, nuts, seeds, or food made from these (e.g. hummus, peanut butter)	[ ]
E 13	*Milk and Milk Products*	Milk, cheese, yogurt or other milk products	[ ]
E 14	Oils and Fats	Oil, fats, or butter added to food or used for cooking	[ ]
E 15	*Sweets*	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	[ ]
E 16	*Spices, Condiments, Beverages*	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages	[ ]
Household level only	Did you or anyone in your household eat anything (meal or snack) OUTSIDE the home yesterday? 1) Yes 2) No		[ ]
Individual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday? 1) Yes 2) No		[ ]

Nutrition Literacy Assessment Instrument (NLAI)				
F. Nutrition and Health				
Question number	***Question***	***Option***	***Answer***	***CODING***
F 1	To lose _____, a person may need to eat fewer calories.	A. weight B. cancer C. fruits D. fitness	1)Correct 2)Wrong	[ ]

F 2	Good _____ may prevent chronic diseases like high blood pressure.	A. eggs B. diabetes C. nutrition D. chicken	1)Correct 2)Wrong	[ ]
F 3	A person who eats too few nutrients may develop _____.	A. fat B. malnutrition C. suicide D. vitamins	1)Correct 2)Wrong	[ ]
F 4	Some nutrients, like _____ should be limited in a healthy diet.	A. fruits B. vegetables C. niacin D. cholesterol	1)Correct 2)Wrong	[ ]
F 5	An example of an energy-dense food is _____.	A. chocolate ice cream (290 calories per 1 cup) B. diced steamed tofu (30 calories per 1 cup) C. sliced fresh papaya (50 calories per 1 cup) D. raw carrot sticks (50 calories per 1 cup)	1)Correct 2)Wrong	[ ]
F 6	Nutrient-dense foods such as _____ should be consumed most often.	A. chocolate ice cream (290 calories per 1 cup) B. French fries (152 calories per 1 cup) C. sliced fresh papaya (50 calories per 1 cup) D. soft drink (100 calories per 1 cup)	1)Correct 2)Wrong	[ ]
G. Macronutrients				
Question number	***Question***	***Option***	***Answer***	***CODING***
G 1	The starch in a bowl of rice is a type of _____.	A. fat B. vitamin C. carbohydrate D. protein	1)Correct 2)Wrong	[ ]
G 2	Foods like oil and butter are often a source of _____.	A. vitamin C B. carbohydrate C. iron D. fat	1)Correct 2)Wrong	[ ]
G 3	The _____ found in orange juice is a type of carbohydrate.	A. sugar B. calcium C. protein D. folate	1)Correct 2)Wrong	[ ]
G 4	A good source of _____ is found in foods like eggs, chicken and fish.	A. starch B. protein C. fiber D. sugar	1)Correct 2)Wrong	[ ]
G 5	Butter, coconut milk, and palm oil all provide high amounts of _____ fat.	A. polyunsaturated B. saturated C. monounsaturated D. trans saturated	1)Correct 2)Wrong	[ ]
G 6	Because they are a good source of _____, vegetarians might eat tempeh and tofu.	A. vitamin D B. vitamin B-12 C. fat D. protein	1)Correct 2)Wrong	[ ]

H. Household Food Measurement				
Sometimes we eat food in the right amounts and sometimes we choose smaller or larger portions. For each food pictured, choose what you think is the right portion size.				
Question number	***Question***	***Option***	***Answer***	***CODING***
H 1	Pictured H1 is one (1) avocado. Is this….. 	A. More than one (1) portion B. Less than one (1) portion C. About right for one (1) portion	1)Correct 2)Wrong	[ ]
H 2	Pictured H2 is one (1) teaspoon of salt. Is this…..  	A. More than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 2)Wrong	[ ]

H 3	There H3 is one (1) cup of rice on this plate, Is this….. 	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 2)Wrong	[ ]
H 4	Pictured H4 is half (1/2) cup of sliced carrot. Is this….. 	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 2)Wrong	[ ]
H 5	Picture H5 is 1 (one) cup of broccoli. Is this…..	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 2)Wrong	[ ]

				
H 6	Pictured H6 is 8 (eight) ounces of tempeh. Is this….. 	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 2)Wrong	[ ]

I. MY PLATE					
This is a list of foods. Using the chart based on the 2014 Balance Diet for Indonesian below, write the name of each food in the food group in which it belongs. **papaya carrot catfish tomato** **water cabbage onions banana** **noodles tempeh spinach rice** **orange juice chicken meatball (bakso) margarine**					
Staple Food	**Vegetables**	**Fruits**	**Meat, Poultry, Fish and Beans**	**Water**	**Sweet, Fats & Oils**

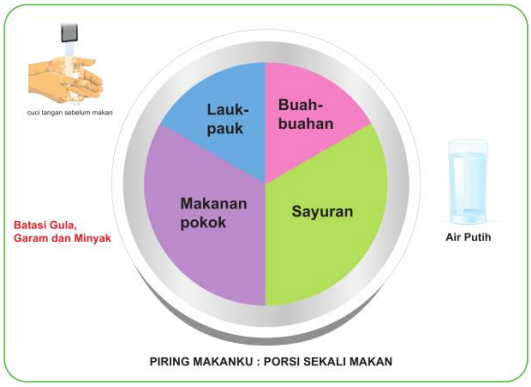

Figure 1 Balance Diet for Indonesian 2014

J. Household Food Insecurity Access Scale (HFIAS) Measurement Tool				
Question number	***Question***	***Option***		***CODING***
J 1	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes		[ ]
J 1a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]
J 2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes		[ ]
J 2a	How often did this happen?	1 = Rarely (once or twice in the past four weeks)		[ ]

		2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		
J 3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes		[ ]
J 3a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]
J 4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes		[ ]
J 4a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]
J 5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes		[ ]
J 5a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]
J 6	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes		[ ]
J 6a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]
J 7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q5) 1 = Yes		[ ]
J 7a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]

J 8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q6) 1 = Yes		[ ]
J 8a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]
J 9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (skip to Q7) 1 = Yes		[ ]
J 9a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)		[ ]

Appendix E - Institutional Review Board Approval Letter for the Randomized Controlled Trial

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Richard Rosenkranz
Human Nutrition
201 Justin

Proposal Number: 7894

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 10/08/2015

RE: Approval of Proposal Entitled, "The effectiveness of Nutrition Education for Overweight/Obese Mother with Stunted Children (NEO-MOM) in reducing double burden of malnutrition."

The Committee on Research Involving Human Subjects has reviewed your proposal and has granted full approval. This proposal is **approved for one year from the date of this correspondence, pending "continuing review."**

APPROVAL DATE: 10/08/2015

EXPIRATION DATE: 10/08/2016

Several months prior to the expiration date listed, the IRB will solicit information from you for federally mandated "**continuing review" of the research**. Based on the review, the IRB may approve the activity for another year. **If continuing IRB approval is not granted, or the IRB fails to perform the continuing review before the expiration date noted above, the project will expire and the activity involving human subjects must be terminated on that date. Consequently, it is critical that you are responsive to the IRB request for information for continuing review if you want your project to continue.**

In giving its approval, the Committee has determined that:

☒ There is no more than minimal risk to the subjects.
☐ There is greater than minimal risk to the subjects.

This approval applies only to the proposal currently on file as written. Any change or modification affecting human subjects must be approved by the IRB prior to implementation. All approved proposals are subject to continuing review at least annually, which may include the examination of records connected with the project. Announced post-approval monitoring may be performed during the course of this approval period by URCO staff. Injuries, unanticipated problems or adverse events involving risk to subjects or to others must be reported immediately to the Chair of the IRB and / or the URCO.

203 Fairchild Hall, Lower Mezzanine, Manhattan, KS 66506-1103 | 785-532-3224 | fax: 785-532-3278 | k-state.edu/research/comply | comply@ksu.edu

Appendix F - Informed Consent for the Randomized Controlled Trial

KANSAS STATE UNIVERSITY

INFORMED CONSENT

PROJECT TITLE:	**The effectiveness of Nutrition Education for Overweight/Obese Mother with Stunted Children (NEO-MOM) in reducing double burden of malnutrition**
APPROVAL DATE OF PROJECT: _____	**EXPIRATION DATE OF PROJECT:** _____
PRINCIPAL INVESTIGATOR: **CO-INVESTIGATOR(S):**	**Dr. Richard Rosenkranz** **Trias Mahmudiono** **Dini Ririn Andrias** **Triska Susila Nindya** **Hario Megatsari**
CONTACT AND PHONE FOR ANY PROBLEMS/QUESTIONS:	**+1 785-532-0152 (USA);** **+62 31 5964808**
IRB CHAIR CONTACT/PHONE INFORMATION:	**Jerry Jaax/ + 1 785-532-5110**
SPONSOR OF PROJECT:	**None**
PURPOSE OF THE RESEARCH:	The goal of NEO-MOM project is reducing child stunting and maternal overweight/obesity in households undergoing double burden of malnutrition through the application of behavioral based nutrition education intervention. This research has two objectives: 1) to apply behaviorally oriented nutrition education (NEO-MOM project) that is based on social cognitive theory towards overweight/obese mother with stunted children 2) to test the effectiveness of NEO-MOM project to reduce maternal overweight/obesity and child stunting
PROCEDURES OR METHODS TO BE USED:	This is a survey using structured questionnaire. Data collection also include measurement of maternal height, weight and waist circumfence; and also child's height/length, and weight assesed in light clothing. Maternal physical activity will be assessed using pedometer

ALTERNATIVE PROCEDURES OR TREATMENTS, IF ANY, THAT MIGHT BE ADVANTAGEOUS TO SUBJECT:
None

LENGTH OF STUDY:	The intervention phase of this study will last for 3 months that consist of 6 sessions of nutrition education (each lasted 50-60 minutes) and 6 sessions motivational interviewing through home visit (each lasted 15-30 minutes). For each baseline and evaluation phase, the data collection will be conducted on two different days. Data collection will be delivered by trained interviewer that visit mother in their house for a face to face interview. On the first day of baseline-evaluation data collection, all item in the questionnaire will be asked including the first 24 hours dietary food recall. The interviewer then explain to mother on how to wear pedometer, and made appointment on when the second day of data collection will be conducted. The first day of baseline-evaluation data collection will

	take around 45 minutes for each participant. On the second day of data collection for each of baseline and evaluation phase, we will only asked for 24 hours dietary recall, dietary diversity and recording maternal step counts in pedometer. The second day will take around 30 minutes to complete.
RISKS ANTICIPATED:	We anticipate minimal risk. There is potential for embarrassment or sensitivity regarding measurement of weight, step counts and reporting of food intake, and physical activity habits.
BENEFITS ANTICIPATED:	Particpants will be compensated a gift in the form of grocery voucher worth $1.50 for their time during baseline and evaluation data collection; Participants in the intervention group will get $1.50 grocery vaucher in biweekly basis for 3 month period of the study; in addition, this project may help to increase participants' knowledge, self-efficacy about their physical activity, eating behavior as well as child feeding behavior
EXTENT OF CONFIDENTIALITY:	We will have a code number for the questionnaire that will be used in data management and will keep participant identity confidential.
IS COMPENSATION OR MEDICAL TREATMENT AVAILABLE IF INJURY OCCURS:	No
PARENTAL OR LEGAL GUARDIAN APPROVAL FOR MINORS:	Yes. *Based on the Indonesian Child Protection Act 2002 (article 1(1) UU No. 23/2002 regarding Child Protection), minors defined as those who aged less than 18 years old including those in the womb. In the case of mothers who are under 18 years old, the Consent Form need to be approved by the husband as their legal guardian after marriage in Indonesia. In case of mothers who are under 18 years old and a widow, the legal guardian will refer to their parent.*

TERMS OF PARTICIPATION: I understand this project is research, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

(Remember that it is a requirement for the P.I. to maintain a signed and dated copy of the same consent form signed and kept by the participant)

Participant Name: _____

Participant Signature: _____ **Date:** _____

Guardian (for minors or Mothers under 18 years old only): _____

Guardian Signature: _____ **Date:** _____

Witness to Signature: (project staff) _____ **Date:** _____

Appendix G - Questionnaire for the Randomized Controlled Trial

RESPONDENT IDENTIFICATION				**CODING**
IRT 1	Respondent ID			
INTERVIEWER IDENTITY				
IP 1	Name of the interviewer			
IP 2	Date of interview			
IP 3	Time of interview	Time started:	Time ended:	

INTERVIEW WAS CHECKED BY:			
Status	**Name**	**Date**	**Signature**
Interviewer			
Supervisor			
Data entry			

A. SUBJECT IDENTITY			**CODING**
A 1	Maternal age	…….. year	
A 2	Child's age	…….. month	
	Child's date of birth	day ...../ month ...../ year	
A 3	Child's sex	1. Male 2. Female	[ ]

B. MEASUREMENT			**CODING**
B 1	Maternal weight	1) .....kg 2)..... kg 3)..... kg Average ……..kg	
B 2	Maternal height	1) .....cm 2)..... cm 3)..... cm Average ……..cm	
B 3	Maternal Waist Circumference	1) .....cm 2)..... cm 3)..... cm Average ……..cm	
B 4	Child's weight	1) .....kg 2)..... kg 3)..... kg Average ……..kg	
B 5	Child's height	1) ..... cm 2)..... cm 3)..... cm Average ……..cm	
B 6	Child's length	1) ..... cm 2)..... cm 3)..... cm Average ……..cm	
B 7	Maternal daily steps count (The first day of interview, enumerator should gave the pedometer along with debriefing on how to wear it to the consented participant. Data will be collected the following day	……..step	

	during 2nd 24 hours dietary food recall)		

A. 24 HOURS DIETARY FOOD RECALL (DAY 1)				
Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning. ***(Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients and the amount consumed. When the respondent has finished, probe for meals and snacks not mentioned.)***				
Time	**Place**	**Meal**	**Details/ Ingredient**	**Amount**

A. 24 HOURS DIETARY FOOD RECALL (DAY 2)				
Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning. ***(Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients and the amount consumed. When the respondent has finished, probe for meals and snacks not mentioned.)***				
Time	**Place**	**Meal**	**Details/ Ingredient**	**Amount**

B. FOOD GROUP (Based on 2nd day 24 hours dietary food recall)			
(When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.)			
Question number	***Food Group***	***Example***	***YES=1 NO=0***
B1	*Cereals*	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, nshima, porridge or paste	[ ]
B 2	*White Roots and Tubers*	White potatoes, White yam, White cassava, or other foods made from roots	[ ]
B 3	*Vitamin A Rich Vegetables and Tubers*	Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper)	[ ]
B 4	*Dark Green Leafy Vegetables*	Dark Green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach	[ ]
B 5	*Other Vegetables*	Other vegetables (e.g. tomato, onion, eggplant) + other locally available vegetables	[ ]
B 6	*Vitamin A Rich Fruit*	Ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits	[ ]
B 7	*Other Fruits*	Other fruits, including wild fruits and 100% fruit juice made from these	[ ]
B 8	*Organ Meat*	Liver, kidney, heart or other organ meats or blood-based foods	[ ]
B 9	*Flesh Meats*	Beef, pork, lamb, goat, rabbit, chicken, duck, other birds, insects	[ ]
B 10	*Eggs*	Eggs from chicken, duck, guinea fowl or any other egg	[ ]
B 11	*Fish and Seafood*	Fresh or dried fish or shellfish	[ ]
B 12	*Legumes, Nuts and Seeds*	Dried beans, dried peas, lentils, nuts, seeds, or food made from these (e.g. hummus, peanut butter)	[ ]
B 13	*Milk and Milk Products*	Milk, cheese, yogurt or other milk products	[ ]
B 14	Oils and Fats	Oil, fats, or butter added to food or used for cooking	[ ]
B 15	*Sweets*	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	[ ]
B 16	*Spices, Condiments, Beverages*	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages	[ ]
Household level only	Did you or anyone in your household eat anything (meal or snack) OUTSIDE the home yesterday? 1) Yes 2) No		[ ]
Individual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday? 1) Yes 2) No		[ ]

Nutrition Literacy Assessment Instrument (NLAI)				
C. Nutrition and Health				
Question number	***Question***	***Option***	***Answer***	***CODING***
C 1	To lose _____, a person may need to eat fewer calories.	A. weight B. cancer C. fruits D. fitness	1)Correct 0)Wrong	[ ]
C 2	Good _____ may prevent chronic diseases like high blood pressure.	A. eggs B. diabetes C. nutrition D. chicken	1)Correct 0)Wrong	[ ]
C 3	A person who eats too few nutrients may develop _____.	A. fat B. malnutrition C. suicide D. vitamins	1)Correct 0)Wrong	[ ]
C 4	Some nutrients, like _____ should be limited in a healthy diet.	A. fruits B. vegetables C. niacin D. cholesterol	1)Correct 0)Wrong	[ ]
C 5	An example of an energy-dense food is _____.	A. chocolate ice cream (290 calories per 1 cup) B. diced steamed tofu (30 calories per 1 cup) C. sliced fresh papaya (50 calories per 1 cup) D. raw carrot sticks (50 calories per 1 cup)	1)Correct 0)Wrong	[ ]
C 6	Nutrient-dense foods such as _____ should be consumed most often.	A. chocolate ice cream (290 calories per 1 cup) B. French fries (152 calories per 1 cup) C. sliced fresh papaya (50 calories per 1 cup) D. soft drink (100 calories per 1 cup)	1)Correct 0)Wrong	[ ]
D. Macronutrients				
Question number	***Question***	***Option***	***Answer***	***CODING***
D 1	The starch in a bowl of rice is a type of _____.	A. fat B. vitamin C. carbohydrate D. protein	1)Correct 0)Wrong	[ ]
D 2	Foods like oil and butter are often a source of _____.	A. vitamin C B. carbohydrate C. iron D. fat	1)Correct 0)Wrong	[ ]
D 3	The _____ found in orange juice is a type of carbohydrate.	A. sugar B. calcium C. protein	1)Correct 0)Wrong	[ ]

		D. folate		
D 4	A good source of _____ is found in foods like eggs, chicken and fish.	A. starch B. protein C. fiber D. sugar	1)Correct 0)Wrong	[ ]
D 5	Butter, coconut milk, and palm oil all provide high amounts of _____ fat.	A. polyunsaturated B. saturated C. monounsaturated D. trans saturated	1)Correct 0)Wrong	[ ]
D 6	Because they are a good source of _____, vegetarians might eat tempeh and tofu.	A. vitamin D B. vitamin B-12 C. fat D. protein	1)Correct 0)Wrong	[ ]

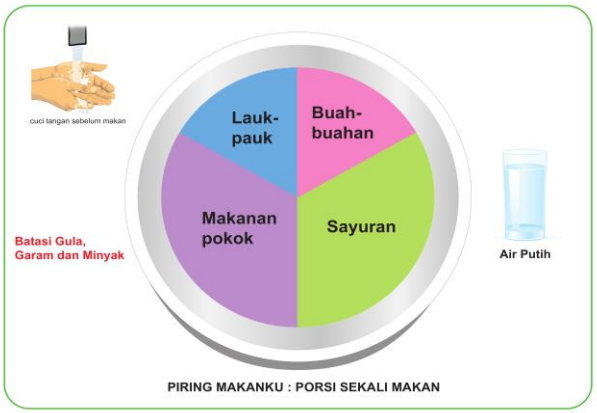

Figure 1 Balance Diet for Indonesian 2014

E. MY PLATE

This is a list of foods. Using the chart based on the 2014 Balance Diet for Indonesian, write the name of each food in the food group in which it belongs.

papaya carrot catfish
tomato
water cabbage onions
banana
noodles tempeh spinach
rice
orange juice chicken meatball (baksо)
margarine

Staple Food	Vegetables	Fruits	Meat, Poultry, Fish and Beans	Water	Sweet, Fats & Oils

F. Household Food Measurement				
Sometimes we eat food in the right amounts and sometimes we choose smaller or larger portions. For each food pictured, choose what you think is the right portion size.				
Question number	***Question***	***Option***	***Answer***	***CODING***
F 1	Pictured F1 is one (1) avocado. Is this….. 	A. More than one (1) portion B. Less than one (1) portion C. About right for one (1) portion	1)Correct 0)Wrong	[ ]
F 2	Pictured F2 is one (1) teaspoon of salt. Is this….. 	A. More than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 0)Wrong	[ ]
F 3		A. more than one (1) portion	1)Correct 0)Wrong	[ ]

	There F3 is one (1) cup of rice on this plate, Is this….. 	B. less than one (1) portion C. about right for one (1) portion		
F 4	Pictured F4 is half (1/2) cup of sliced carrot. Is this….. 	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 0)Wrong	[ ]
F 5	Picture F5 is 1 (one) cup of broccoli. Is this…..	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 0)Wrong	[ ]

				
F 6	Pictured F6 is 8 (eight) ounces of tempeh. Is this….. 	A. more than one (1) portion B. less than one (1) portion C. about right for one (1) portion	1)Correct 0)Wrong	[ ]

MATERNAL SELF-EFFICACY		
G. Self-Efficacy to Be More Physically Active (Barrier) ***Question:*** A number of situations are described below that can make it hard to be more physically active. Please rate in each of the blanks in the column how certain you are that you can get yourself to be more physically active.		
Rate your degree of confidence by recording a number from 0 to 100 using the scale given below: 0 10 20 30 40 50 60 70 80 90 100 Cannot do at all — Moderately can do — Highly certain can do		
Question number	***Statement***	***Confidence***

		(0-100)
G 1	When I am feeling tired	[ ]
G 2	During bad weather	[ ]
G 3	During or after experiencing personal problems	[ ]
G 4	When I am feeling depressed	[ ]
G 5	When I am feeling anxious	[ ]
G 6	After recovering from an illness or injury	[ ]
G 7	When I feel physical discomfort when I exercise/walk	[ ]
G 8	During or after a holiday/vacation	[ ]
G 9	When I have too much work to do at home	[ ]
G 10	When there are other interesting things to do	[ ]

H. Self-Efficacy to Be More Physically Active (Task)

Studies show that most adults accumulate about 3,000 to 9,000 steps per day, but 10,000 steps per day is a level associated with health gains. If you were asked to be physically active by taking a specific number of steps per day right now, how certain are you that you can achieve each level of physical activity described below?

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question number	***Statement***	***Confidence (0-100)***
H 1	Take 1,000 steps per day	[ ]
H 2	Take 2,000 steps per day	[ ]
H 3	Take 3,000 steps per day	[ ]
H 4	Take 4,000 steps per day	[ ]
H 5	Take 6,000 steps per day	[ ]
H 6	Take 8,000 steps per day	[ ]
H 7	Take 10,000 steps per day	[ ]
H 8	Take 12,000 steps per day	[ ]

I. Self-Efficacy to Eat Fruit (Barrier)

This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for mother to stick to a diet that include fruit. Please rate how certain you are that you can do the things discussed below by writing the appropriate number. Your answers will be kept strictly confidential and will not be identified by name.

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question number	***Statement***	***Confidence (0-100)***
I 1	Eating fruit when eating out	[ ]
I 2	Eating fruit at the end of the month	[ ]
I 3	Choose fruit over desert/sweets during a party or celebration	[ ]
I 4	Eating fruit for snack over fried food or chips.	[ ]
I 5	Purchase fruit even if you know your husband will not agree	[ ]
I 6	Purchase fruit even if it is more expensive than other food	[ ]

J. Self-Efficacy to Eat Vegetables (Barrier)

This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for mother to stick to a diet that include vegetables. Please rate how certain you are that you can do the things discussed below by writing the appropriate number. Your answers will be kept strictly confidential and will not be identified by name.

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question number	***Statement***	***Confidence (0-100)***
J 1	Eating vegetables when eating out	[ ]
J 2	Eating vegetables at the end of the month	[ ]
J 3	Choose vegetables or salads over desert/sweets during a party or celebration	[ ]
J 4	Eating vegetables or salads for snack over fried food or chips.	[ ]

J 5	Purchase vegetables even if you know your husband will not agree	[ ]
J 6	Purchase vegetables even if it is more expensive than other food	[ ]

K. Self-Efficacy to Eat Fruit (Task)

Based on the 2014 Indonesian Balance Diet guidelines, eating 2-3 serving of fruit per day is associated with health gains. If you were asked to eat fruit by taking a specific serving per day right now, how certain are you that you can achieve each level of serving described below?

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question number	***Statement***	***Confidence (0-100)***
K 1	Eating fruit one serving per day	[ ]
K 2	Eating fruit in every meal or 2-3 servings per day	[ ]
K 3	Eating fruit more than 3 servings per day	[ ]
K 4	Purchase fruit right after your/your husband's payday (get the salary)	[ ]
K 5	Purchase fruit one week after your/your husband's payday (get the salary)	[ ]
K 6	Purchase fruit two after your/your husband's payday (get the salary)	[ ]
K 7	Purchase fruit three week after your/your husband's payday (get the salary)	[ ]
K 8	Purchase fruit four week after your/your husband's payday (get the salary)	[ ]

L. Self-Efficacy to Eat Vegetables (Task)

Based on the 2014 Indonesian Balance Diet guidelines, eating 3-4 serving of vegetables per day is associated with health gains. If you were asked to eat vegetables by taking a specific serving per day right now, how certain are you that you can achieve each level of serving described below?

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question number	***Statement***	***Confidence (0-100)***

L 1	Eating vegetables 1-2 servings per day	[ ]
L 2	Eating vegetables in every meal or 3-4 servings per day	[ ]
L 3	Eating vegetables more than 4 servings per day	[ ]
L 4	Purchase vegetables right after your/your husband's payday (get the salary)	[ ]
L 5	Purchase vegetables one week after your/your husband's payday (get the salary)	[ ]
L 6	Purchase vegetables two after your/your husband's payday (get the salary)	[ ]
L 7	Purchase vegetables three week after your/your husband's payday (get the salary)	[ ]
L 8	Purchase vegetables four week after your/your husband's payday (get the salary)	[ ]

M. Self-Efficacy to Provide Animal Protein for Child's Meal (Barrier)

This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for mother to prepare child's meal that consist of animal protein. Please rate how certain you are that you can do the things discussed below by writing the appropriate number. Your answers will be kept strictly confidential and will not be identified by name.

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100
Cannot do at all — Moderately can do — Highly certain can do

Question number	***Statement***	***Confidence (0-100)***
M 1	Purchase animal protein if you know your husband will not agree	[ ]
M 2	Cooking animal protein other than frying method	[ ]
M 3	Cooking your child's meal even though many street vendors available	[ ]
M 4	Feed your child with animal protein even if he/she cry	[ ]
M 5	Feed your child with animal protein without forcing them to eat	[ ]
M 6	Cooking your child's meal when you feel of having limited time to prepare	[ ]
M 7	Purchase animal protein at the end of the month	[ ]
M 8	Feed your child with animal protein even if it's more expensive than other food	[ ]
M 9	Feed your child with animal protein even if it's not readily available	[ ]

M 10	Feed your child with animal protein even if you don't have fridge in your house	[ ]

N. Self-Efficacy to Provide Animal Protein for Child's Meal (Task)		
Based on the 2014 Indonesian Balance Diet guidelines, eating 2-4 serving of protein is associated with health gains. If you were asked to provide your child with the easily digest animal protein in their meal, how certain are you that you can achieve each level of activities described below?		
Rate your degree of confidence by recording a number from 0 to 100 using the scale given below: 0 10 20 30 40 50 60 70 80 90 100 Cannot do at all — Moderately can do — Highly certain can do		
Question number	***Statement***	***Confidence (0-100)***
N 1	Purchase milk/dairy as a part of your family's shopping list	[ ]
N 2	Purchase fish as a part of your family's shopping list	[ ]
N 3	Purchase egg as a part of your family's shopping list	[ ]
N 4	Purchase chicken as a part of your family's shopping list	[ ]
N 5	Purchase liver as a part of your family's shopping list	[ ]
N 6	Getting your child drink milk once per day	[ ]
N 7	Getting your child drink milk 2-4 times per day	[ ]
N 8	Getting your child eat fish once per day	[ ]
N 9	Getting your child eat fish 2-4 times per day	[ ]
N 10	Getting your child eat egg once per day	[ ]
N 11	Getting your child eat egg 2-4 times per day	[ ]
N 12	Getting your child eat chicken once per day	[ ]
N 13	Getting your child eat chicken 2-4 times per day	[ ]
N 14	Getting your child eat ate liver once per day	[ ]
N 15	Getting your child eat liver 2-4 times per day	[ ]

O. Outcome Expectations for Being More Physically Active	**Please choose your answer**

Question Number	If I am being more physically active every day…	I disagree very strongly	I disagree	I disagree a little	I agree a little	I agree	I agree very strongly
O 1	I will become stronger	1	2	3	4	5	6
O 2	my family will start being physically active too	1	2	3	4	5	6
O 3	I will have stronger body	1	2	3	4	5	6
O 4	I will have a nicer smile	1	2	3	4	5	6
O 5	I will be healthier (rarely sick)	1	2	3	4	5	6
O 6	it may help me lose weight	1	2	3	4	5	6
O 7	I will have more energy	1	2	3	4	5	6
O 8	I will be able to think better/smarter	1	2	3	4	5	6
O 9	I will have longer breath	1	2	3	4	5	6
O 10	I will have more peace of mind	1	2	3	4	5	6

P. Outcome Expectations for Eating FVs		**Please choose your answer**					
Question Number	If I eat fruits and vegetables every day…	I disagree very strongly	I disagree	I disagree a little	I agree a little	I agree	I agree very strongly
P 1	I will become stronger	1	2	3	4	5	6
P 2	my family will start eating them too	1	2	3	4	5	6
P 3	I will have stronger eyes	1	2	3	4	5	6
P 4	I will have a nicer smile	1	2	3	4	5	6
P 5	I will be healthier (rarely sick)	1	2	3	4	5	6
P 6	it may help me lose weight	1	2	3	4	5	6
P 7	I will have more energy	1	2	3	4	5	6
P 8	I will be able to think better/smarter	1	2	3	4	5	6
P 9	I will have smoother skin	1	2	3	4	5	6
P 10	I will have longer satiety	1	2	3	4	5	6

Q. Outcome Expectations for Providing Animal Protein for Child's Meal		**Please choose your answer**					
Question Number	If I provide animal protein for my child every day…	I disagree very strongly	I disagree	I disagree a little	I agree a little	I agree	I agree very strongly
Q 1	My child will become taller	1	2	3	4	5	6
Q 2	My child will become smarter	1	2	3	4	5	6
Q 3	My child will have stronger eyes	1	2	3	4	5	6
Q 4	My child will have a nicer smile	1	2	3	4	5	6
Q 5	My child will be healthier (rarely sick)	1	2	3	4	5	6
Q 6	it may help my child gain more weight	1	2	3	4	5	6
Q 7	My child will have more energy	1	2	3	4	5	6
Q 8	My child will be more active	1	2	3	4	5	6
Q 9	My child will less cranky	1	2	3	4	5	6
Q 10	My child will have longer satiety	1	2	3	4	5	6