博士論文

論文題目　The Double Burden of Malnutrition within Household:

An Investigation of Diet and Physical Activity in West Java, Indonesia

（世帯内で生じる栄養不良の二重負荷

―インドネシア・西ジャワにおける食事・身体活動の調査―）

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Abbreviations and acronyms

BAZ	BMI-for-Age Z-score
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CDC	Centers for Disease Control
DB	Double Burden
DBM	Double Burden of Malnutrition
DHS	Demographic and Health Survey
EI	Energy Intake
GNP	Gross National Product
HAZ	Height-for-Age Z-score
HH	Household
ICC	Intraclass Correlation Coefficient
IOTF	International Obesity Task Force
MET	Metabolic Equivalent
NCD	Non-Communicable Disease
NCHS	National Center for Health Statistics
NHANES	National Health And Nutrition Examination Survey
ON	Overnutrition
PA	Physical Activity
SES	Socioeconomic Status
US	United States
UN	Undernutrition
WAZ	Weight-for-Age Z-score
WC	Waist Circumference

WHO	World Health Organization
WHZ	Wight-for-Height Z-score

Definitions

Excess body weight	Comprises overweight and obesity.
Malnutrition	Comprises both overnutrition and undernutrition.
Normal	In terms of nutritional status, not overnourished or undernourished.
Obesity	Having a body mass index of 30.0 or more.
Overnutrition	In adults, overweight or obesity. In children, above two standard deviations from mean height for age, weight for age or weight for height of the reference population, or above one standard deviation from the mean body mass index for age of the reference population.
Overweight	Having a body mass index between 25.0 and 30.0.
Stunting	Below minus two standard deviations from mean height for age of the reference population.
Undernutrition	In adults, underweight. In children, stunting, underweight or wasting.
Underweight	In adults, having a body mass index below 18.5. In children, below minus two standard deviations from mean weight for height or body mass index for age of the reference population.
Wasting	Below minus two standard deviations from mean weight for age of the reference population.

Abstract

The coexistence of undernutrition and overnutrition is termed the double burden (DB) of malnutrition and increasing attention has been paid to this issue occurring within households.

In Chapter 1 earlier articles were reviewed to determine the DB prevalence, its associated factors and the analytical methods used to examine it. Thirty five articles were identified. Prevalence estimates varied substantially by analytical method. African countries were assessed most frequently. Although socioeconomic factors were often assessed, the role of intermediate factors for nutritional status remains unclear. Future studies should ensure comparability, study Asian countries and intermediate factors.

In Chapter 2 data was used from field surveys conducted in Bandung and Sumedang, West Java, Indonesia, to investigate the mechanisms of the DB by assessing diets and physical activity (PA). Questionnaire-based interviews and anthropometry was obtained from 486 individuals, and diet and PA information from 294 individuals. Body mass index was correlated positively with fat intake. PA and dietary patterns were associated with individual social characteristics in Sumedang but less in Bandung. Intraclass correlation coefficients for energy and protein intake were smaller in Bandung. Overnourished individuals in DB households were more likely to be adult, less active and get less energy from fat and staple grains compared to other overnourished individuals. It is indicated that this “paradoxical” phenomenon seem understandable if the possibility is accepted that: nutritional and dietary patterns and physical activity levels are not necessarily determined by social characteristics shared within households; and that household members did not have similar diets and PA.

General Introduction

It has been a couple of decades since the obesity epidemic began to emerge in the developing countries. Although undernutrition has been a dominant concern that has persisted in developing countries for a long time, together with developed countries, these countries are now experiencing overnutrition as a growing threat that cannot be ignored. Generally, the decrease in undernutrition and increase in overnutrition are described in relation to the nutrition transition (Doak et al., 2005).

The nutrition transition refers to a series of changes in dietary patterns that have occurred throughout human history driven by social and economic factors that have varied from the onset of animal husbandry and agriculture in the early ages to industrialization and urbanization in the last few centuries (Popkin, 1993). In this spectrum, the changes in body composition we are facing now are seen as a consequence of the shift away from a diet primarily based on staple grains, vegetables and fruits that are locally available, toward a diet higher in fat, sugar, animal-origin foods and processed food that is lower in fiber (Popkin, 1998). Today, more generally, the idea of the nutrition transition is also regarded as including a series of changes in physical activity in addition to dietary changes, and that both factors are contributing to

the changes in body composition.

In contrast to the Western countries which passed through this transition over a long period of time, in an ordered manner, developing countries have had much less time, and are experiencing it at a much faster rate (Shrimpton and Rokx, 2013; Haddad et al., 2014). As a consequence of the rapidity and drastic nature of these changes, the highest rate of growth in the prevalence of excess body weight from 1980 to 2008 was observed in South East Asia, followed by Oceania, Sub-Saharan Africa and Latin America (Haddad et al., 2014).

The decrease in undernutrition, on the other hand, is not proportional to the increase in overnutrition. Using data from multiple countries and years, Ruel et al. (2013) estimated that, with a 10% increase in gross domestic product per person, stunting in children and underweight in women decreased by 5.9% and 4.0% respectively, while excess body weight increased by 7.0%. As a result of the gap between these rates, many developing countries are now simultaneously faced with an increasingly high prevalence of overnutrition together with persistent undernutrition. This coexistence of undernutrition and overnutrition is termed the “double burden of malnutrition”.

In the last decade, an increasing amount of attention has been paid to the

emergence of the double burden of malnutrition within households, that is, the coexistence of overnutrition and undernutrition among the members of a single household. One of the earliest studies that paid attention to this phenomenon which was conducted by Doak et al. (2000), investigated the double burden of malnutrition within households using nationwide surveys in Brazil, China and Russia. It found that underweight and overweight coexisted within 8~11% of households, and argued that the highest prevalence was found in the country in the midst of rapid transition (i.e. Brazil). Regarding the association between the double burden within households and economic development, Garrett and Ruel (2005a) explored the prevalence of the co-occurrence of child undernutrition and maternal overweight, and showed a reverse U-shaped relationship with economic development. The prevalence of the double burden peaked at around 1,500 US dollars per capita gross national income (GNP) (the author's own calculation on the basis of equations presented in the paper).

The causes and effects of malnutrition, including both under- and overnutrition, are inter-generational (Darnton-Hill et al., 2004; Shrimpton and Rokx, 2013), and thus the intra-household coexistence of the two different forms of malnutrition has been described as “paradoxical” (Doak et al., 2005; Jehn and Brewis, 2009). The coexistence of overnourished parents and children within households is possibly explained by the

genetic background or obesogenic lifestyles that are shared by the members. The coexistence of undernourished parents and children within households, on the other hand, can be explained by an absolute shortage of resources in the household or shared lifestyles that can cause undernutrition. In these situations interventions targeted at both parents and children should be more effective than those addressed to them separately.

However, effective interventions are difficult in a condition where the double burden of malnutrition exists, and there is an urgent need to determine the mechanisms that underlie the development of the "paradoxical" disparity in nutritional status in order to plan effective response measures. For example Ruel et al (2013) reported unintended results of cash/food transfer program in Mexico. Presuming that causes of undernutrition were in poverty, the government implemented a program that aimed to improve nutritional status of poor households by providing them with cash or foods. However, together with improved household dietary quality, significant excess weight gain was observed in already overweight and obese women at the baseline. The double burden of malnutrition in targeted population and households and its mechanisms need to be recognized and understood for planning successful strategies.

This thesis consists of two chapters. In Chapter 1, a review of the earlier literature was undertaken aiming to provide an overview of the current situation of the

73 double burden of malnutrition within households and the research that has occurred on
74 it. Chapter 2 reports the results of a field survey in West Java, Indonesia. By quantitative
75 evaluation of diets and physical activity, it investigates the mechanisms of the double
76 burden of malnutrition within households.

1. A Review of the Prevalence and Predictors of the Double Burden of Malnutrition within Households

1.1. Introduction

In recent years, the phenomenon of the double burden of malnutrition has attracted more and more researchers. However, despite the increasing attention being focused on this topic, as yet, to the best of my knowledge, there have been no review articles published in scientific journals that have focused primarily on this topic. The existence of the phenomenon of the double burden within households has been mentioned in review articles whose main topics were, for example, obesity in developing countries (Prentice, 2006), and maternal health (Delisle, 2008). A discussion paper by the World Bank attempted to review the causes and solution to the double burden at the individual, household and country levels (Shrimpton and Rokx, 2013). However, most of the discussion was devoted to the double burden at the country level and little was mentioned about the burden within households. A comprehensive assessment of the prevalence and predictors of the double burden within households across countries is thus lacking.

This chapter aims to provide an overview of the current situation of the double

burden of malnutrition within households and the research that has occurred on it, by undertaking a review of the earlier literature about this phenomenon. Specifically, the geographical and chronological trends in the prevalence of this phenomenon and its associated factors were examined as well as the research methods used in the studies. In addition, the association between the prevalence of the double burden and economic development was examined using a wider ranging dataset extracted through the reviewing process.

1.2. Methods

1.2.1. Inclusion criteria

The below criteria were used to identify eligible studies/literature.

- Literature where the author(s) conducted an original analysis either using secondary data or based on an original survey, thus review articles were excluded (no meta-analysis was found).
- Literature that reported the prevalence of households with a double burden of malnutrition.
- Literature published by the end of June, 2015.
- Literature where a full-text version was available in English.

113

114 1.2.2. Information source, search, and study selection

115 Studies were identified using the PubMed and Web of Science electronic
116 databases. The following search terms were used: “(dual OR double) burden
117 (malnutrition OR household)”. After screening by titles and abstracts of the records in
118 the search results, the author examined the full-text versions of all the identified articles
119 to determine their potential eligibility. During this eligibility assessment, the literature
120 cited in these articles was also screened based on the titles, and those that were judged
121 as eligible were added to the pool of potential articles that would be examined. The
122 whole process is illustrated in a flow diagram with the number of records in Figure 1-A.

123 Post-hoc search using the terms listed below resulted in the same 35 articles
124 after the examination procedure.

125 - ((maternal OR mother) AND (overweight OR obese OR obesity)) AND ((child OR
126 children) AND (stunting OR stunted OR underweight OR undernutrition))
127 - ((parent OR parental) AND (overweight OR obese OR obesity)) AND ((child OR
128 children)
129 - “under/over” AND (household OR pair)
130 - paradoxical AND malnutrition AND (household OR pair)

- (intra OR within) AND household AND nutritional AND inequality

1.2.3. Data collection

Information was extracted from the literature that was judged as eligible using a data extraction form. Below are the items included in the database (or data extraction form).

- Publication information: name of the journal, year of publication, volume and page numbers.
- Data: country, area, data source, year of data collection, characteristics of the subjects (e.g., slum residents, refugees), number of subjects analyzed.
- Methods: focused combination of under- and overnourished persons (e.g., overnourished mother and undernourished child), the age range of adults and children, nutritional indicators used to identify under- and overnutrition of adults and children.
- Results: the number and prevalence of households/pairs with a double burden of malnutrition, associated factors.

For the sake of comparison, crude prevalence rates were retrieved preferentially if available, since some studies only reported crude (unadjusted) values. For this purpose

149 the number of cases was retrieved in addition to the reported prevalence. For studies
150 that analyzed multiple datasets (multiple countries and/or years) or that used multiple
151 indicators, information was extracted for each result.
152
153 ## 1.3. Results
154 ### 1.3.1. Study selection and data collection
155 A total of 35 articles were finally identified as being eligible for inclusion in
156 the current review. A flow diagram of the selection process and the number of records in
157 each phase is shown in Figure 1-A. The search of PubMed and the Web of Science
158 returned 257 and 310 records respectively. After removing duplicates and screening by
159 the titles and the abstracts, 50 articles remained. Reasons for exclusion included: a focus
160 on other topics (not on the double burden of malnutrition), a focus on the
161 population-level double burden of malnutrition, and that there was no abstract written in
162 English. Through the examination of the full-text of the 50 articles, 22 were excluded
163 due to: being narrative reviews without original data analysis (9 articles), having no
164 full-text available that was written in English (5), because the prevalence of double
165 burden households/pairs was not reported (3), or because there was a different focus (2;
166 e.g., on the association between maternal height and child fatness), or because the

167 double burden of malnutrition was examined but at the population level (3).

168 During this examination of the 50 articles, 26 articles were additionally
169 identified from the reference lists and they were examined as well. Of these, 19 were
170 excluded due to: being narrative review articles (6 articles), having a different focus (4),
171 because the prevalence was not reported (3), the focus on the double burden of
172 malnutrition was at the individual level (2) or the population level (1), they were one of
173 multiple publications (2) or because no English full-text version was available (1).

174 Using the data extraction form, 367 prevalence figures were obtained from 35
175 articles.

176

177 1.3.2. Study characteristics

178 Characteristics of the included studies are summarized in Table 1-A. Except for
179 one study published in 1995, all of the others were published in 2000 or later, with 23
180 being published in 2010 or later.

181

182 1.3.2.a. Data source

183 Of the 35 articles, 23 used secondary data such as the Demographic and Health
184 Surveys (6 articles). In total, 70 countries were identified in the extracted data, of which

50 were low or lower-middle income countries; 37 were in Africa. Of the 367 sets of data extracted, the year of data collection ranged from 1988 to 2012.

1.3.2.b. Analysis

Among the 35 studies, 25 limited their focus to pairs of undernourished children and overnourished mothers. The age range of the children and adults varied between studies; one study categorized individuals aged 19 years old as children, while another study categorized those aged 12 years old as adults. As for the nutritional status of adults, BMI was a commonly used indicator: for the cut-off, 31 studies used a BMI figure of 25.0, three used 30.0 and two used 23.0 for the classification of adults' overnutrition. Indicators for the child's nutritional status, on the other hand, differed somewhat by study. Although the HAZ score was most frequently used, weight-for-age, weight-for-height and BMI-for-age z-scores (WAZ, WHZ and BAZ) were also used in multiple studies. Among those studies that used z-scores, the World Health Organization (WHO) references released in 2006 for children under 5 years of age and in 2007 for those aged 5-19 years were used most frequently for the classification. Until the release of these WHO international references, the one from the US National Center for Health Statistics (NCHS)/WHO had been recommended internationally for the assessment of

nutritional status, and it was also used in studies about the double burden within households. However, the reference was based on data only surveyed in the US, and did not adequately represent growth in early childhood (de Onis, 2006). The difference between the growth curves of the latest WHO references and the NCHS/WHO reference is remarkable for weight for age and weight for height: for example, a -2 standard deviation of weight for age for boys aged 4 months is 5.6kg in the latest WHO reference and 4.7kg in the NCHS/WHO reference. Since different references may result in an individual's nutritional status being classified differently, the interpretation of results requires careful consideration especially when the subject is mismatched to the reference population.

1.3.2.c. Reported items

Of the 35 studies, 18 reported prevalence value(s) but without specifying the actual number of households/pairs identified as experiencing a double burden of malnutrition. Twenty-five studies reported factors associated with the double burden within households together with the prevalence. A wide variety of factors were assessed from community social capital to intestinal parasites. Frequently assessed factors included maternal age and education, urban/rural residence, household size and income.

The reference group that was used for comparisons with double burden household/pairs differed by study, and some conducted multiple comparisons using different references. The most commonly used reference group was households/pairs that consisted of individuals of normal nutritional status (11 studies), followed by nine studies where double burden households/pairs were compared with all households/pairs other than the double burden households/pairs.

1.3.3. Prevalence of households with a double burden of malnutrition

The reported prevalence figures are shown in Table 1-B, by the combination of malnourished persons and nutritional indicators, and country. When comparing indicators, the prevalence of stunted child and overweight mother pairs was higher than that of wasting child and overweight mothers, even though the prevalence of both combinations was lower than 10% in many countries examined. Exceptions include Guatemala (10.7~20.0%), Egypt (10.9~16.0% except in 2003) and Bolivia (11.0~11.5% in 1998) for stunted child and overweight mother pairs. Comparing 56 countries by the latest national prevalence of the combination of stunted child and overweight or obese mothers, revealed that there was a low prevalence in countries in Asia and Africa (Nepal, Ethiopia, Kazakhstan and Central African Republic for example), while a high

prevalence was observed in Central or South America and Africa (Guatemala, Egypt, Ecuador and Lesotho for example). Among 42 countries that were analyzed for multiple years in a comparative way (using the same indicators/cut-offs for the same combination of under- and overnourished persons), the prevalence increased in 27 countries, decreased in 11 countries and did not change in one country when comparing the earliest and the latest figures (in Ghana, Nigeria and Zambia, it differed by indicator and combinations).

The reported prevalence differed substantially by age range for children and adults. Examples can be seen with the results from Garrett and Ruel (2005a), Garrett and Ruel (2005b) and Dieffenbach and Stein (2012). They used the same indicators and cut-offs for both children and adults (a -2 HAZ for children and a BMI of 25.0 for adults) but Dieffenbach and Stein limited the age range for children from two to five years, while Garrett and Ruel set a wider range from six to 60 months in both of their studies. Garrett and Ruel estimated a higher prevalence than Dieffenbach and Stein for many countries or years. Among 19 studies that further limited the age range in addition to the existing limitation of the available age range of the secondary or reference data they used, only three justified this limitation. Reasons given included the unstableness of HAZ for children aged 2 years or younger (Dieffenbach and Stein, 2012), or because

257 of comparability issues with other studies (Lee et al., 2012).

258

259 1.3.4. Factors associated with the double burden of malnutrition within households

260 Urban/rural residence, income and the maternal/household head's education

261 were frequently assessed for their association with the double burden within households.

262 For these three factors, the results are summarized in Table 1-C by reference group.

263

264 1.3.4.a. Urban/rural

265 Taking normal, under- or overnourished households/pairs or all of these as a

266 reference for comparisons, there were 37 analytical cases that explored the association

267 between urban/rural residence and the double burden of households/pairs. In 21 cases

268 there was a positive relationship with urban residence, in 15 there was no significant

269 relationship while only one of them had a negative relationship.

270 Causes of overnutrition can be related to the double burden as well, since the

271 rapid increase in overnutrition can be a key factor in the rise in the double burden in a

272 situation where a corresponding decrease in undernutrition is slow. Therefore suggested

273 pathways between urban residence and the double burden within households include

274 inactivity and obesogenic diets. Roemling and Quaim (2013) found that the prevalence

of overnourished households was higher in urban areas, as well as double burden households, and noted that urban environments offer a greater variety of food choices, including processed or fast-food items, and jobs with lower levels of physical activity. Doak et al. (2002) attributed the high probability of double burden households being in urban areas to the fact that the nutrition transition begins in urban areas first. In another article, Doak et al. (2005) explored the interaction between urban residence and income, and reported that, among the seven countries they assessed, the urban effect was somewhat lower in low-income households in the Kyrgyz Republic, Russia and Vietnam, while the effect was greater in low-income households in China and Indonesia. However, the study did not investigate this further or try to explain the mechanisms that might underlie these differences.

1.3.4.b. Income

Compared to urban residence, results about the relationship between income and the double burden were mixed. When compared to normal households double-burden households tended to have a higher income, while many studies found no significant difference in the relationship between income and the double burden when comparing these households with undernourished households.

As noted above, an interaction between income and urban residence was reported (Doak et al. 2005). Jehn and Brewis (2009) suggested that it might be a possible cause of the mixed results, introducing a study which reported that, among Brazilian women who moved to urban areas and had insufficient income, the prevalence of both under- and overweight was higher than women who moved to urban areas and had higher income.

1.3.4.c. Maternal/household head's education

The association between nutritional status and educational background is also a topic that many researchers are interested in. Among 12 results, four showed a negative relationship between higher education and the double burden within households, five found no significant relationship and three studies reported a positive association.

Better knowledge about health and nutrition may link education and the double burden. Jehn and Brewis (2009), who indicated that the double burden within households was a by-product of the rapid increase in overnutrition in the absence of any substantial improvement in undernutrition, mentioned that there was a decline in obesity rates with education. On the other hand, an association between maternal education and child undernutrition has also been reported. Lee et al. (2012) showed that households

311 with highly educated mothers were less likely to have a stunted child, and more likely to
312 be double burden households. Vaezghasemi et al. (2014), while citing a paper by Rae
313 (1999), noted that mothers' education contributes to a better intake of protein and
314 vitamins, which can improve nutritional status. Leroy et al. (2014) put emphasis on the
315 effect of maternal education on mitigating the negative effect of wealth on child and
316 maternal nutrition, possibly explaining the association between education and the
317 double burden.
318
319 1.3.4.d. Other factors
320 Six results were reported about the relationship between the household heads'
321 sex and the double burden within households. Male-headed households were reported to
322 be more likely to have a double burden in three analyses (reference No. 22 (two results),
323 25 and 31) and less likely in one analysis (reference No. 20). On the other hand,
324 children's sex was reported to have no significant association in all three studies that
325 examined it (reference No. 12, 18 and 27).
326 The mothers' or the household heads' age was examined in eight analyses.
327 Compared to normal households the households/pairs with a double burden were likely
328 to have an older head or mother (reference No. 22 and 33) as well as when they were

329 compared to all the households without a double burden (reference No. 18 and 22).
330 Compared to the overnourished households, the heads/mothers in the households/pairs
331 with a double burden were more likely to be younger (reference No. 22).
332 Doak et al. (2002) used a secondary dataset with household dietary information
333 obtained by the 24-hour recall method, and compared the proportion of energy intake
334 from carbohydrate, protein and fat in the households with a double burden with that in
335 the other household categories. The households with a double burden tended to have: a
336 lower percentage of energy intake from carbohydrate compared to the underweight
337 households and the normal households; a higher percentage of energy intake from
338 protein compared to the normal households; and a higher percentage of energy intake
339 from fat compared to the underweight households. Interestingly no significant
340 difference was found when they were compared with the overweight households.
341
342 1.4. Discussion
343 Today, the increase in excess body weight is sometimes said to be a pandemic
344 rather than an epidemic, and recognized not only among researchers and policy makers
345 but also among the general public. Obesity is one of the most important causes of
346 non-communicable diseases (NCDs) in developed countries. Recently, a high

prevalence of obesity has also been observed in some developing countries, where a large portion of deaths is attributable to NCDs (Mendis et al. 2015). Health policies in developing countries, that have until now been focused on undernutrition are now facing the need to deal with overnutrition. Since there has not been a complete shift from one to the other but rather the emergence of a situation where there is a coexistence of both, policies need to focus on overnutrition simultaneously with undernutrition. In this chapter, I conducted a review of the published literature, focusing on the double burden of malnutrition within households.

During the 20 years since Sawaya et al. (1995) reported that 9% of households in Brazil had overnourished and undernourished members living together, a total of 35 studies have been published which were deemed as being eligible for inclusion in this literature review. Most of them were published in 2010 or later, indicating that this topic has been attracting more academic interest in recent years.

The national prevalence of households with a double burden found in this literature ranged from 0.0% to 26.8%. This reflects differences in the combinations of under- and overnourished persons examined, nutritional indicators, cut-offs and age ranges that were used in each study, in addition to the differences in country that were being studied, the years when the studies took place and the sources of the data that

were used. Some studies focused only on mother-child pairs while others assessed all the household members. While some studies used HAZ as an indicator of undernutrition, others used WHZ. Also, the variability in age classification between studies could be great as indicated by the fact that while one study included 12-year-old individuals as adults another classified 19-year-old individuals as children. Due to these differences, the reported figures are not easily compared between the studies. Even though 367 sets of prevalence numbers were extracted from the 35 studies, only a few were directly comparable. Based on the age range of the children, the combination of under- and overnourished persons and nutrition indicators and cut-offs, the largest group that was comparable included only 13 studies (i.e., children aged under 2 years with a HAZ score below -2 and the mother with a BMI larger than 25.0), although two of these were specifically focused on urban or rural areas in the country concerned.

Nevertheless, trends can be explored, even though this has to rely strongly on a small number of studies that calculated prevalence figures for many countries using secondary data. Among the 42 countries that were assessed in a way where they were comparable to each other, an increase in the double burden of malnutrition was observed in 27 countries. However, the distribution of the subject countries and areas suggests an important research gap. While many studies assessed low- and

middle-income countries, the situation in developed countries is still unclear. Additionally, African countries were frequently studied but Asian countries were studied less often, even though more than half of the world's obese population is living in this region.

Studies that conducted original surveys and ones that focused on specific countries or areas, provided information about the predictive factors for the double burden of malnutrition within households. By looking at the factors assessed in multiple studies, it seems that households with a double burden have certain characteristics in common, although methods and definitions differed by study. Examples are higher income and urban residence in the country, and a higher level of education of household heads. However, neither urban residence, higher income nor education directly brings about undernutrition or overnutrition. It is the poor quality of nutritional intake and/or the imbalance between energy intake and expenditure that brings undernutrition and overnutrition, and they are strongly defined by dietary intake and physical activity. Studies suggested possible pathways between urban residence, income and education, and dietary intake and physical activity, however, most of them were speculative based on earlier studies and not using their own findings as evidence. Probably the main reason is because they used secondary data and did not have information about dietary

401 practices or physical activity. Even among those studies with dietary or physical activity
402 information, the quality of this information was not good enough for a detailed
403 assessment. For example, dietary information from a food frequency questionnaire is
404 not appropriate for assessing the absolute value of nutritional intake. Future studies
405 should examine how diets and physical activity are affected by factors reported to be
406 associated with the double burden within households, using in-depth investigative
407 methods.

408 In summary, three recommendations can be made for future studies,: 1) to use
409 comparable indicators and cut-offs, 2) to study Asian countries, 3) to investigate
410 individual dietary intake and physical activity. The prevalence of the households with a
411 double burden of malnutrition was shown to have been increasing until now, and it is
412 expected to increase even more in the coming years. Accordingly, the importance and
413 necessity of studying the double burden of malnutrition within households will become
414 even greater.

2. Investigation of the Mechanisms of the Double Burden of Malnutrition: The Results of a Field Survey in West Java, Indonesia

2.1. Introduction

Indonesia provides a suitable setting to study the double burden of malnutrition, a phenomenon that has been reported more and more frequently in developing countries. Here the scenario of the double burden of malnutrition, where the rate of increase in overnutrition is exceeding the rate of decrease in undernutrition, is mirroring that which is occurring in other parts of the developing world. According to the World Health Organization (WHO), the prevalence of child stunting in the country decreased from 48.1% in 1995 to 39.2% in 2010, and 36.4% in 2013. On the other hand, the rise in overnutrition has been greater than this. The prevalence of excess body weight among adults has increased from 20.8% (2010) to 24.4% (2014, data for 2013 were unavailable in the same database). While the decrease in child stunting in the 2010-2013 period was -2.4%/year, the rate of change in adult excess body weight was +4.1%/year (WHO Global Health Observatory Data Repository (http://apps.who.int/gho/data/), accessed on Sep. 22, 2015). Consequently, the phenomenon of the double burden of malnutrition has been reported at the country level.

Furthermore the phenomenon has been observed within households. Roemling and Qaim (2013) analyzed a nationally representative survey and reported that while 11.1% of households had a double burden of malnutrition in 1993, by 1997 the rate had increased to 16.3% and to 16.8% in 2000. Even though the prevalence decreased slightly to 16.1% in 2007, the Theil index, a continuous measure they adapted from an economic study as an indicator of within-household inequality, continued to grow between 1997 and 2007. This means that the disparities in the nutritional status of members in the same household have become greater. Oddo et al. (2012) also used national surveillance data, to explore what factors were associated with mother-child double burden pairs in Indonesia compared to in Bangladesh. Their results showed that higher maternal age, larger household size and higher per capita household expenditure were significant predictors, whereas maternal higher education was protective against the double burden. In developing countries that are in an earlier phase of economic development and nutrition transition, there is a positive association between socioeconomic status and overweight (Garrett and Ruel, 2005), and they suggested that this might be a possible explanation for the positive association of household expenditure and the double burden. Regarding education, Vaezghasemi et al. (2014) noted that it could positively influence the consumption of important nutrients,

contributing to a better nutritional status. They also reported the same trend of household wealth and the double burden, using a composite score of household assets and facilities: the double burden was more prevalent in wealthier groups.

Nevertheless, the mechanisms underlying the emergence of the double burden within households remain unclear. As discussed in the previous chapter, few studies have examined the direct determinants of nutritional status, i.e., dietary intake and physical activity in association with the double burden within households. Dietary intake and physical activity are intermediate factors that bridge the gap between individual characteristics such as age, sex and socioeconomic status and nutritional status (Figure 2-A). The objective of the present study therefore was to investigate the mechanisms of the double burden of malnutrition within households by the quantitative evaluation of diets and physical activity in rural and urban areas in West Java, Indonesia.

The double burden of malnutrition within households has been viewed as paradoxical (Doak et al., 2005; Jehn and Brewis, 2009), and much effort has been made to characterize these households and to elucidate the determinants of this phenomenon. One of the primary reasons why the existence of the double burden within households

has been questioned and viewed as paradoxical, is because it is assumed that the nutritional status of members in the same household should be similar.

The household, or family in a wider sense, is unique to *Homo sapiens* and is believed to have been of benefit for the survival of the species. It has conventionally been regarded as a fundamental unit of food production and consumption, and economic activities. In other words, household members are supposed to share the labor burden, and food and economic resources of the household. Based on this, intra-household variations in physical activity, food intake and economic status are expected to be smaller than their inter-household variation. Regardless of the fact that little quantitative evidence exists in relation to this, researchers have assumed this occurred in both pre-industrial and industrial societies. For example, in human ecology studies in Papua New Guinea, individual nutritional intake has been estimated from the amount of food items consumed in the household assuming that the members consumption was in proportion to the BMR of each individual (e.g., Ohtsuka et al., 1985; Umezaki et al., 1998). In studies undertaken in industrial societies, household heads' income and occupation are commonly used as a proxy measure for children's socioeconomic status. This leads to the idea that the nutritional status of members in the same household

should be similar, and that therefore, households with a double burden, where two different forms of malnutrition coexist, appear paradoxical.

Examined deductively, this idea is based on several underlying assumptions. Therefore, I would like to raise and examine these assumptions. The emergence of households with a double burden, or paradoxical households, could be understood reasonably well when the following assumptions are not fully supported:1) the nutritional status of an individual is influenced by the balance of energy intake and expenditure; 2) nutritional and dietary patterns and physical activity, that determine the energy balance, are influenced by household income, occupation and other lifestyle factors; and 3) household members share resources and circumstances and are not independent of each other, and therefore they have similar nutritional and dietary patterns and physical activity levels. Hereafter I would like to refer to these assumptions as Assumption 1, 2 and 3 respectively, and examine them using data collected during the field surveys.

2.2. Methods

The field surveys took place in the periods from August to November, 2014, and from February to March, May to June and August to September, 2015, covering 23

503 weeks in total. They did not include the fasting period. The present study was approved
504 by the Research Ethics Committee of the Graduate School of Medicine and Faculty of
505 Medicine, the University of Tokyo (Approval Number 10485-(1), Appendix 1).
506 Research permissions from the local governments in West Java were also obtained
507 through Padjadjaran University.
508
509 2.2.1. Study areas
510 West Java is one of 33 provinces in Indonesia, situated in the western part of
511 Java Island, as the name literally says. There are several levels and categories of
512 administrative unit in the province (Figure 2-B). The province of West Java is divided
513 into 27 *kota* and *kabupaten*, including *kota* Bandung and *kabupaten* Sumedang (see
514 Appendix 2 for a map), where the field surveys were conducted. *Kota* Bandung, the
515 capital of the province, is located in the center of the province, and *kabupaten*
516 Sumedang is located in the northeast. According to the 2010 census Bandung has a
517 population of nearly 2.4 million people located within an area of 167km^2 (14,317
518 person/km^2), while Sumedang has 1.1 million people in 1,518km^2 (720 person/km^2). As
519 the word "*kota*" means "city", a large part of Bandung is a crowded urban area, which
520 contrasts markedly with Sumedang, where the land is used largely for agriculture with

only a scattering of towns. These two areas were purposively chosen to compare by the level of economic development. Since Sundanese people comprise a large majority both in Bandung and Sumedang, these areas share the same fundamental culture and values. Also, these two areas are at a similar altitude (around 700~1,000m above sea level), and therefore have a similar climate throughout the year.

Kota and *kabupaten* are divided into several smaller area levels: *kecamatan*, *kelurahan*/*desa*, *rukun warga (RW)* and *rukun tetangga (RT)*. The field surveys were conducted in four *RT*, two of which were from two *RW* in Bandung and the other two were from two *RW* in Sumedang.

The villages in Sumedang extended along hill ridges. The relatively wealthier households faced the main roads in the village. Less wealthy households were located behind these houses. There were terraced fields where rice and vegetables are grown, while traditional agroforestry is undertaken on the inclines surrounding the village. Since there were few place to shop, housewives bought materials for cooking at home from itinerant peddlers, or harvested them from the surrounding fields. Salted and dried fish are popular in this setting due to their low price and preservability. Housewives cooked once a day or once in every two days, and household members ate whenever, and as much as they wanted by themselves. Therefore household members did not

539 necessarily have meals together even when they were all at home. Those who worked
540 outside the villages or students in schools located away from the villages often bought
541 food and ate it at simple eating places or stalls on their way to and from the villages.
542 Two *RT* in Sumedang were chosen as study locations since many people there were
543 involved in double cropping of rice and sweet potato or agroforestry, and their
544 livelihood has traditionally relied on agriculture.

545 In contrast, in Bandung, there was no farmland within the city. According to
546 the census (Badan Pusat Statistik Kota Bandung, 2014), only 1% of the working
547 population engaged in agriculture, while the majority, 35%, were engaged in trading.
548 There were markets only a few minutes' walk from the surveyed communities where
549 vegetables, fresh meat and fish, ready-made dishes and snacks, and dairy necessities
550 were sold. Due to this better availability of a wide range of foods, salted fish was rarely
551 eaten. Also, even beyond the market, it was not difficult to find stalls selling snacks and
552 light meals on the streets. Similar to in Sumedang, people ate whenever and as much as
553 they wanted but they ate take-away foods at home more often here. Two *RT* in Bandung
554 were chosen based on their having available statistics about child undernutrition (Dinas
555 kesehatan kota Bandung; unpublished data) and the location: the proportion of
556 undernourished children was at an average level here, and they were located in the

557 central part of the city. This was important since even in Bandung the peripheral areas
558 were hilly and had a much smaller population density.
559
560 2.2.2. Data collection
561 2.2.2.a. Questionnaire and anthropometry
562 First, all the households in the four *RT* were visited and members were
563 provided with information about the study. For the households that agreed to participate,
564 questionnaire-based interviews were conducted and anthropometric data were collected
565 for all of the current members. The participation rate in this phase was 75% (66/88
566 households, that consisted of 270 individuals) in Bandung and 95% (79/83 households,
567 that consisted of 216 individuals) in Sumedang. Besides gathering basic information
568 such as on age and sex, the questionnaire also included items on marital status,
569 educational background, employment status and job type, and individual monthly
570 income (Appendix 3). In the case of seasonal workers, average monthly income was
571 calculated. Anthropometry data included measurements of weight and height. Identical
572 equipment was used in all study sites. Height was measured with a portable stadiometer
573 to the nearest 0.1cm, and weight was measured with a portable digital scale in units of
574 100g. For the measurement, participants wore light clothing and took off caps, shoes

575 and socks. Children aged two years or younger were excluded from the anthropometric
576 data collection.

577 Based on the anthropometry, three categories of individual nutritional status
578 were assessed: undernutrition, overnutrition and normal, using body mass index (BMI)
579 and z-scores of height for age (HAZ), weight for age (WAZ), weight for height (WHZ)
580 and BMI for age (BAZ). These nutritional indicators were used since their validity have
581 been established in multiple ethnic groups internationally, better than other indicators.
582 Table 2-A shows the classification of individual nutritional status.

583 For children and adolescents (228 months or younger), nutritional status was
584 categorized using HAZ, WAZ, WHZ and BAZ, calculated using the WHO Child
585 Growth Standards (Anthro and Anthro Plus). If any of the HAZ, WAZ, WHZ or BAZ
586 scores was below minus two, the child was categorized as being undernourished (de
587 Onis et al., 2006). If WHZ was above two or BAZ was above one, the child was
588 categorized as being overnourished. HAZ and WAZ scores were not used to categorize
589 overnutrition because no cut-off point has been identified in previous studies as being a
590 predictive value for child overnutrition (Stettler et al., 2007; Lutter et al., 2011). The
591 BAZ cut-off was set as one because it was almost equivalent to a BMI of 25.0 at the age
592 of 19 years, which was the cut-off used for adults (older than 228 months; Bellizzi and

Diez, 1999; de Onis et al., 2007). WHZ scores for those aged 61 months or older were not calculated since a corresponding weight-for-height growth reference was not provided by the WHO. Children and adolescents who were not identified as being under- or overnourished were categorized as normal.

Adults' nutritional status was categorized using BMI: those with a BMI below 18.5 were categorized as being undernourished (underweight); those with a BMI of 25.0 or higher were categorized as overnourished (overweight); and those with a BMI between 18.5 and 25.0 were categorized as normal (World Health Organization, 1999). Although Asian-specific cut-off values have been proposed based on the risk of type 2 diabetes and cardiovascular diseases (Barba et al., 2004), international cut-off values were used in this study to ensure comparability with other studies.

According to individual nutritional status, households were categorized as being undernourished, overnourished, having a double burden or as normal, following the criteria used in the studies by Doak et al. (2005), Grijalva-Eternod et al. (2012) and Roemling and Quaim (2013). Undernourished households were those with at least one undernourished member and no overnourished ones. Similarly, overnourished households were those with at least one overrnourished member and no undernourished ones. If there was at least one overnourished member and at least one undernourished

member in the same household, then the household was categorized as having a double burden. Normal households comprised only normal individuals, i.e., they had no undernourished or overnourished members.

Although different forms of genetic relatedness between under- and overnourished persons (e.g. between parents and children, between siblings or between husbands and wives) might have different causes and give rise to different interpretations, I did not limit the combination of under- and overnutrition to children and the mother or parents. This study aimed to investigate the mechanisms of within-household nutritional disparity by focusing on diets, physical activity and the pathways shown in Figure 2-A, as the effects genetics might have on the relationship between individual characteristics, dietary and physical activity patterns and nutritional status has not yet been established.

2.2.2.b. Dietary survey

The second phase consisted of the simultaneous assessment of diet and physical activity of individuals. Due to the greater burden for participants, some of the households that agreed to participate in the first phase (for the questionnaire and anthropometric data collection) declined or were not able to participate in this phase. In

Bandung, an Indonesian assistant, local health workers and the author visited households and gave instructions. After the three-day survey periods, we visited each household again to collect and check their records. Eight households were purposively chosen in the first *RT*, and all the households that agreed to participate were included in the second *RT*. However, many of the subjects worked and had meals outside home almost every day, and elderly couples could not fully understand and follow the instructions. As a result, their food intake information was excluded from the dietary and nutritional analysis. Finally, from the households that participated in the first phase, the proportion of households with valid dietary and physical activity data was 29% (19/66 households and 92/270 individuals after excluding six households due to poor data quality) in Bandung. In Sumedang, three Indonesian assistants and the author visited households and gave instructions. Since there were more elderly and illiterate participants here, we visited households regularly and sometimes stayed nearby to check and help them during the survey periods. From three to five households were covered by one assistant at a time. The proportion of households with valid data was 95% (75/79 households, 202/216 individuals) in Sumedang. Hereafter, the "core sample" refers to these households and members from which valid data was collected.

In the dietary survey, all the foods and beverages that the participants consumed were recorded for three days (including two weekdays and one Saturday, Sunday or holiday) using the weighed dietary records method. On the day before the survey period, digital scales (KD-177, Tanita, Japan) were distributed to each household together with recording sheets (Appendix 4 and 5). During the three-day period the participants were asked to weigh the amount of food items they would eat, drink and that they leftover every time, and write down the time, place, name of the food item, and weight on the recording sheets. In case they ate outside, approximate portion sizes were estimated by interviewing them.

To assess the nutritional intake patterns, total energy intake and energy intake from protein, fat and carbohydrate were calculated using Indonesian food composition tables (Departmen Kesehatan Indonesia, 1990; 1993; 1995; 2001) and the Indonesian version of the Nutrisurvey software (available at http://www.nutrisurvey.de/, downloaded in September, 2014). For dishes not found in these databases, nutritional values were estimated using common recipes in the areas that were obtained through interviews and observation with weighing. To adjust for body size, total energy intake was divided by basal metabolic rate (BMR) calculated using Henry's (2005) equations for different sex and age categories, which use weight and height. Energy intake from

664 protein, fat and carbohydrate was converted into percentages of energy intake.

665 “Nutritional intake pattern indicators” refers to the total energy intake and energy intake

666 from protein, fat and carbohydrate hereafter.

667 For dietary pattern assessment, food items were grouped into dietary categories

668 based on the main ingredients (grain/tubers, vegetables/legumes, meat/fish, egg, fruits,

669 dairy products and others), and energy intake from each dietary category was calculated.

670 Energy intake from rice and vegetables was calculated separately from the grain/tubers

671 and vegetable/legumes category, since they possibly characterized individual dietary

672 patterns better due to the greater individual dietary variation observed in the field.

673 “Dietary intake pattern indicators” refers to the energy intake from each dietary

674 category hereafter.

675

676 2.2.2.c. Physical activity survey

677 For the same three-day period, physical activity levels were measured by

678 accelerometer (Lifecorder EX, Suzuken, Japan). The accelerometer records the intensity

679 of physical activity in every two minute period along with the daily total step counts.

680 Vertical acceleration is detected and classified into 11 levels of intensity (0, 0.5 and

681 1~9) every four seconds, and the mode during every two minute period is recorded as

682 the intensity of physical activity in that period. Using the conversion equation
683 developed by Kumahara et al. (2004), corresponding metabolic equivalent (MET) was
684 calculated for each level of intensity measured. MET is defined as the ratio of energy
685 expenditure of a specific activity compared to that of sitting quietly (Ainsworth et al.,
686 2000). Energy expenditure on an activity can be estimated by using the MET value
687 together with the duration time and body weight as:
688 [Energy expenditure (kcal)] = MET × [Duration time (hour)] × [Bodyweight (kg)]
689 Accelerometers and instructions (Appendix 6) were distributed together with
690 dietary recording sheets on the day before the survey periods began, and collected on
691 the first day after the periods ended. All accelerometer data were manually checked
692 after being downloaded to a personal computer. If any of the participants wore it for less
693 than six hours, or went for a period of longer than three hours where no movement was
694 registered, then the person-day observations were excluded. Five households in
695 Bandung and two households in Sumedang had members who had no valid physical
696 activity data and thus were not included in the household-level analysis.
697
698 2.2.3. Analysis

Initially, the association between nutritional intake and physical activity, and individual nutritional status was examined by fitting least squares regression models (2.2.3.a) to test Assumption 1. Regarding Assumption 2, potential predictors of nutritional and dietary intake patterns and physical activity were explored (2.2.3.b). To examine Assumption 3, that the nutritional and dietary intake pattern and physical activity levels were similar among household members, intraclass correlation coefficients (ICCs) were calculated (2.2.3.c). Potential predictors of the double burden within households were explored next (2.2.3.d). Finally, to determine if individuals in double burden households had distinctive characteristics, logistic regression analyses were conducted separately for under- and overnourished individuals, with being a member of a household with a double burden as the binominal outcome (2.2.3.e). Except for the assessment of the predictors of the double burden within households (2.2.3.d), only data from the core sample was analyzed. The details of each analysis are described in the following subsections. Households that consisted of only one person were excluded from the analysis.

2.2.3.a. Association between nutritional intake patterns and physical activity level, and individual nutritional status

To examine which nutritional intake and physical activity factors were associated with individual nutritional status, regression models were fitted using BMI as the dependent variable. Model 1, as the null model, included age, age-squared and sex as independent variables. Model 2 included physical activity level in addition to the variables in Model 1. Model 3 also included energy intake per BMR. The full model, Model 4, included the proportion of energy intake from protein and fat in addition to all of the other variables. An age-squared term was included since a nonlinear association was expected based on the age-BMI plot, especially at a younger age.

2.2.3.b. Individual determinants of dietary/nutritional intake and physical activity

The association between individual characteristics and dietary/nutritional intake and physical activity level was also examined. Additionally, per capita income was also assessed even though it was a household rather than an individual characteristic. The Kruskal-Wallis equality-of-populations rank test was used for the comparison of dietary/nutritional intake patterns and physical activity level by sex, educational background, and occupation, while Spearman's rho was used for the assessment of the association with age and income.

735 2.2.3.c. Within-household cohesiveness of dietary/nutritional intake patterns and
736 physical activity level
737 To test the assumption that members in the same household have a similar food
738 intake and physical activity patterns, ICCs were calculated. Individuals were nested
739 within households in this model. ICC is the proportion of the between-cluster variance
740 from the overall variance, and increases when the between-cluster variance increases
741 against the within-cluster variance (Rabe-Hesketh and Skrondal, 2012). In this case, the
742 cluster represents the household as a unit, and the ICC is the proportion of the
743 between-household variance. Thus higher values indicate higher within-household
744 cohesiveness. Additionally, since the ICCs of groups with different numbers of
745 observations nested in each cluster (i.e., different household sizes in this case) are
746 comparable, values for Bandung and Sumedang were calculated separately to observe
747 the difference.
748
749 2.2.3.d. Comparing characteristics of double burden households with other households
750 Characteristics were compared by household category (i.e., undernourished,
751 overnourished, double burden and normal), to investigate the predictors of double
752 burden households. Assessed factors included: number of household members, monthly

753 per capita income, area (Bandung/Sumedang), household head's educational
754 background and sex. The Kruskal-Wallis equality-of-populations rank test was used to
755 compare numerical variables (i.e., the number of members and monthly income), while
756 the Chi-square test was used for the other categorical variables. The whole sample was
757 included in this analysis.
758
759 2.2.3.e. Predictors of being in a double burden household among malnourished
760 individuals
761 In an attempt to determine the predictors of being a member of a double burden
762 household, logistic regression analyses were conducted separately for under- and
763 overnourished individuals. In the analysis, being a member of a household with a
764 double burden was the binominal outcome, while being a member of an undernourished
765 or overnourished household was the base outcome. Independent variables included age
766 group (adult/child), sex, physical activity, energy intake, and energy intake from protein,
767 carbohydrate, fat, grain/tubers, vegetables/legumes and meat/fish.
768
769 2.3. Results
770 2.3.1. Sample description

Table 2-B shows household characteristics by area. The “core sample” refers to the subgroup that participated in all aspects of the study, i.e., in the questionnaire, anthropometry, dietary and physical activity data collection among the “whole sample”, which includes households that did not participate in the dietary and physical activity survey. The mean number of household members was smaller in Sumedang, mainly due to old couples living separately from their children who lived and worked outside the villages. Even excluding the largest family that had 13 members in Bandung, the mean was 4.0 persons/household among the whole sample and 4.4 persons/household among the core sample. Roemling and Quaim (2013) calculated the mean household size as 4.3 persons/household in Indonesia using a pooled nationally representative sample from 1993-2007. Compared to this figure, the household size in Sumedang was much smaller. Median monthly income was higher in Bandung, while the 25-75th percentile for income was larger in Sumedang, suggesting greater economic disparity. Double burden households comprised 36.4% of the households in Bandung and 16.5% in Sumedang. Among 37 double burden households, 35 had undernourished child(ren) and 29 had an overnourished mother (Table 2-C). Thus the most common combination was undernourished child(ren) and an overnourished mother (28 households).

788 The characteristics of the study participants are shown in Table 2-D (a) and (b).
789 Among the "whole sample" (Table 2-D (a)), the proportion of adults was larger in
790 Sumedang (74.5%) than Bandung (67.4%) and their mean age was higher, suggesting a
791 larger proportion of old people. While more than half of all adults had a primary or
792 lower level of education in Sumedang, the majority in Bandung had a high school or
793 higher education. Among males, the major occupational category was non-sedentary
794 work, while for females it was being a housewife in both areas, although the proportion
795 of housewives was smaller in Sumedang. As for nutritional status, for both sexes the
796 mean BMI was higher in Bandung than in Sumedang, similar to the higher prevalence
797 of overnutrition. Considering that a WHO (2014) report stated that the national average
798 BMI was 22.4 for males and 23.4 for females, the participants had a generally higher
799 BMI except for males in Sumedang. Overnutrition was observed most frequently among
800 female adults in Bandung, whereas undernutrition was found most frequently among
801 male children in Sumedang.
802 Table 2-D (b) shows participants' level of physical activity and patterns of
803 nutritional/dietary intake among the "core sample", in addition to their basic
804 characteristics. In general, the level of physical activity measured by accelerometer was
805 higher among males than females, among children than among adults and in Sumedang

compared to in Bandung. Comparing adults between the areas, energy intake was higher in Bandung in both sexes. The proportion of energy intake from protein and fat among adults in Sumedang was smaller than for children in Sumedang, and when compared to adults and children in Bandung. Instead, energy intake from carbohydrate was larger than in the other groups. Considering the biological requirement for protein set by the WHO (2007; 0.66g/kg/day), 16.7% and 40.9% of participants did not meet the criteria in Bandung and Sumedang respectively (data not shown).

2.3.2. Association between nutritional intake patterns and physical activity level, and individual nutritional status

The results from fitting regression models for BMI with physical activity level and nutritional patterns are shown in Table 2-E. Across the models, age, age-squared and sex were consistently correlated: BMI was predicted to be highest around the age of 46~49 years, and higher in females. Also, BMI was not significantly correlated with physical activity level but with nutritional intake. A higher energy contribution from fat predicted higher BMI, while, unexpectedly, a higher energy intake adjusted by BMR predicted lower BMI. A separate analysis by area did not reveal any substantial difference (Appendix 7).

824

825 2.3.3. Individual determinants of dietary/nutritional intake and physical activity

826 The upper half of Table 2-F shows the association between individual
827 characteristics and physical activity level. In Sumedang, males, students and younger
828 people tended to have a higher level of physical activity. The lower half of the table
829 shows the association between individual characteristics and energy intake. The only
830 significant determinant of energy intake was found for occupation in Sumedang,
831 indicating that workers engaging in non-sedentary jobs were more likely to have a
832 higher energy intake, although the difference with people in other job categories was
833 small. Both for physical activity and energy intake, no significant associations were
834 found in Bandung.

835 The association between individual characteristics and protein, carbohydrate
836 and fat intake is shown in Table 2-G. For protein, carbohydrate and fat intake, there was
837 an association with education, occupation, age and per capita household income, but
838 only in Sumedang. Adults with a higher education tended to get more energy from
839 protein but less from carbohydrate. Higher income produced a similar finding: those
840 with a higher income obtained more energy from protein and fat but less from
841 carbohydrate. In contrast, workers in non-sedentary jobs tended to get less energy from

protein and fat but more from carbohydrate. Higher age also had a negative association with protein and fat intake and a positive association with carbohydrate intake. Interestingly, different associations were found for income and fat intake by area. Members of households with a higher income obtained more from fat in Sumedang.

In Table 2-H, the association between individual characteristics and dietary intake patterns is shown. Dietary categories that made a greater contribution to total energy intake were assessed. Energy intake from grain/tubers had similar associations to those seen for carbohydrates: adults with higher education and those with a higher income consumed less grain/tubers. Regarding vegetable/legume intake, occupation and income were associated in both areas. Housewives and workers with sedentary jobs, and those with a higher income were likely to consume more vegetables/legumes. Also, higher age was positively associated with energy intake from vegetables/legumes in Bandung. Similar to fat, different associations were found regarding income and meat/fish intake by area. Those with a higher income obtained less energy from meat/fish in Bandung but more in Sumedang. This was probably because of area differences in food availability.

2.3.4. Within-household cohesiveness of dietary/nutritional intake patterns and physical activity levels

The ICCs of physical activity and nutritional/dietary indicators are shown in Table 2-I. Here, a higher ICC value means higher within-household cohesiveness. The overall ICC for physical activity level was 0.22, indicating low within-household cohesiveness. Comparing nutritional intake patterns by area, large differences were found in energy and protein intake. Bandung had lower scores (0.23 and 0.18 respectively) than Sumedang (0.45 and 0.33 respectively). Compared by household category, double burden households had lower values for physical activity (0.19), energy (0.32) and protein intake (0.33), and higher values for carbohydrates (0.52), fat (0.59) and grain/tubers (0.48). Households with an undernourished child and overnourished adult, and those with an undernourished child and overnourished mother had similar ICC values to the double burden households (Appendix 8).

2.3.5. Comparing characteristics of double burden households with other households

Characteristics were compared by household nutritional category (Table 2-J). The number of household members was higher in double burden households than in the other household categories. This seems natural, since the probability of under- and

877 overnutrition coexisting is higher with a larger number of household members. Also, the
878 distribution of the household nutritional categories differed by area. As many as 36.4%
879 of the households in Bandung were categorized as having a double burden, while the
880 figure was only 16.5% in Sumedang. In terms of household heads' education, the
881 proportion of double burden households was higher among households whose heads had
882 a higher educational background. Households with an undernourished child and
883 overnourished adult and those with an undernourished child and overnourished mother
884 had similar characteristics to the double burden households (Appendix 9 and 10).
885
886 2.3.6. Predictors of being in a double burden household among malnourished
887 individuals
888 Table 2-K shows the results of fitting separate logistic regression models for
889 under- and overnourished individuals, where being in a double burden household was
890 the outcome. For undernourished individuals no significant predictor of being a
891 double-burden household member was found. On the other hand, among overnourished
892 individuals, being an adult, doing less physical activity, and getting less energy from
893 carbohydrates, fat and grain/tubers was significantly associated with being a member of
894 a double burden household. Adjusting by area did not significantly alter these results

(Appendix 11). Limiting the sample to undernourished children and overnourished adults, and limiting overnourished double burden households to those with an undernourished child and overnourished adult or those with an undernourished child and overnourished mother produced similar results (Appendix 12~14).

2.4. Discussion

2.4.1. The double burden within households as a paradox

To explore the mechanisms underlying the emergence of the double burden of malnutrition within households, this study conducted field surveys in Bandung and Sumedang in West Java, Indonesia. The two areas were strategically chosen as representing different types of living environment: the communities in Sumedang were surrounded by agricultural fields and agroforestry, and represented a rural farming area where people engaged in agriculture; the communities in Bandung were at the center of a crowded city, and represented an urban area where people relied on cash-labor. From the 145 households surveyed 37 were classified as having a double burden of malnutrition. The proportion was higher in Bandung (36.4%) than in Sumedang (16.5%).

In the Introduction I presented three assumptions (Assumptions 1~3) to be examined as ideas underlying the view of the double burden within households as being paradoxical. They will be examined in the following subsections while using dietary and physical activity data from West Java, Indonesia, that refer to that specific context.

2.4.1.a. Assumption 1: individual nutritional status is defined by the energy balance

The nutritional status of healthy individuals is expected to be determined by the energy balance in their lives. The results from fitting regression models for BMI indicated that, besides age and sex, energy intake adjusted by BMR and the energy contribution of carbohydrates could predict individual nutritional status in West Java. The significant association between the energy contribution of carbohydrates and BMI indicates that the nutritional composition may be associated with nutritional status, as well as total energy intake. This is consistent with what previous studies have suggested (e.g., Garrett and Ruel, 2005). However, the result that a higher energy intake per BMR was associated with lower BMI in our results, is contrary to the expectation. Taken together, this first assumption was not necessarily supported with my data in West Java.

Even though energy intake was divided by BMR in order to adjust the value to body size, there might have been a possibility of over-adjustment, which resulted in a

930 negative relationship between energy intake and BMI. In addition, the precision of the
931 estimation based food intake information collected by weighed dietary record method
932 might be insufficient. Also, it is well known that overnourished individuals tend to
933 underreport their food intake (e.g. Scagliusi, 2009).
934 Regarding protein intake, according to our dietary survey, 34.5% of
935 participants consumed less than the biological requirement set by the WHO (2007;
936 0.66g/kg/day), which might be a cause of undernutrition particularly among children.
937 Micronutrients deficiency, especially lack of vitamin A, had been prevalent among
938 children in Indonesia (Pangaribuan et al., 2003). Although the government has
939 conducted a program of vitamin A supplementation for children aged under five twice a
940 year, it has been reported that the coverage differs substantially by community (Dinas
941 kesehatan kota Bandung, 2014; unpublished data). In areas with poorer coverage,
942 children might have lacked vitamin A, which could have impeded their healthy growth.
943 The occurrence of metabolic diseases, protein or micronutrients deficiency among
944 individuals might explain the lack of an expected relationship between nutritional status
945 and energy balance in the present study. This should be a focus for future research.
946

947 *2.4.1.b. Assumption 2: nutritional/dietary patterns and physical activity levels are*
948 *influenced by individual socioeconomic and lifestyle factors*

949 With regard to this second assumption, the associations between nutritional and
950 dietary patterns and physical activity, and the participants' characteristics were
951 examined. As indicators of socioeconomic status, educational background, occupation
952 and per capita household income were all assessed as well as sex and age. The results
953 revealed a marked contrast between urban and rural areas regarding the association of
954 individual characteristics with nutritional and dietary patterns and physical activity
955 levels. In Sumedang, the physical activity level and nutritional and dietary patterns were
956 significantly related to individual characteristics such as age and sex, socioeconomic
957 status, and household income. Notably, energy intake from protein, carbohydrate, fat,
958 grain/tubers, vegetables/legumes and meat/fish was associated with per capita
959 household income there. On the other hand in Bandung, neither physical activity level,
960 total energy intake, energy intake from protein, carbohydrate, fat, nor grain/tubers were
961 associated with any of the assessed factors. This should not be attributed solely to the
962 smaller size of the sample in Bandung, considering the actual distributions and statistics.
963 Instead, it can be interpreted as showing that the dietary and physical activity patterns of
964 people in Sumedang were more strongly determined by socioeconomic status, while

965 those of people in Bandung were affected more by personal preferences or
966 circumstances. In this case the second assumption was not supported in Bandung, where,
967 indeed, a higher prevalence of households with a double burden was observed.
968 Also, it seems consistent in relation to the dietary change that occurs during the
969 nutrition transition that people with a higher socioeconomic status come to consume
970 less carbohydrate and rice, and more protein, fat and meat (Popkin, 1998). But, this was
971 seen mainly in Sumedang, an area that seems to be in the middle of a drastic change in
972 the nutrition transition, while Bandung, which is considered to be more developed and
973 urbanized, seems to have moved beyond this phase.
974 Many previous studies have examined the association between the double
975 burden within households and urbanization using an urban and rural dichotomization. A
976 majority of these studies reported that households in urban areas were more likely to
977 have a double burden (e.g., Doak et al., 2000; Dop et al., 2012;Vaezghasemi, 2014),
978 while some studies reported the opposite result (e.g., Roemling and Quaim, 2013; Parra
979 et al., 2015). These inconsistent findings might be because the focus has been on the
980 relative level of domestic urbanization in each country, but not on the actual phase of
981 the nutrition transition. In the present case of Sumedang, an area experiencing
982 socioeconomic development and with it, a rapid change from diets based on staple

grains to diets higher in fat and meat, the prevalence of double burden households was lower, and physical activity levels and nutritional/dietary patterns were associated with individual characteristics such as age, sex, occupation and educational level. Meanwhile in Bandung, an area in a more advanced phase of nutritional transition, the prevalence was higher, while physical activity and nutritional/dietary patterns were hardly associated with individual characteristics. I wish to therefore emphasize the importance of evaluating the phase of the nutritional transition when studying the association between the double burden within households and urbanization.

2.4.1.c. Assumption 3: household members share similar nutritional intake patterns and physical activity levels due to the shared resources and circumstances

Similarities in nutritional intake patterns and physical activity levels of members in the same household were assessed with ICCs. Most of the ICCs for physical activity levels and nutritional intake patterns were below 0.50, which indicates that intra-household variations in nutritional intake and physical activity levels were larger than inter-household variations. The ICCs for physical activity levels were exceptionally low, indicating that there was great variation in the physical activity levels among household members. Furthermore, areal comparison revealed smaller ICCs for

energy and protein intake in Bandung than in Sumedang, which concurs with the higher prevalence of double burden households in Bandung. Large variations in energy and protein intake within households can lead to a large variation in the nutritional status within households, that is, to a double burden of malnutrition within households. Indeed, double burden households had smaller ICCs for energy and protein intake when compared by household category.

According to my observations in the field, household members, except for housewives and young children, spent long periods of time outside the home. After breakfast children and male adults went out either to school or their workplace, some by motorbike and some on foot, and had snacks and lunch at various locations. Even in the farmer households in Sumedang, I never saw all the members of a family working together. Based on what was observed there, it is possible that members of the same household had quite different lifestyles in terms of what they specifically ate and how much physical activity they did. Nevertheless, household members did share a common economic situation. In wealthy households, members owned their own personal motorbikes and had a different dish for every meal. In poor households, on the other hand, at most they possessed just one motorbike shared by all the members, and had the same dish repeatedly for several days.

Taking these actual situations into consideration, the relatively low ICC values probably depict the rather large variations in nutritional intake patterns and physical activity levels reasonably well. This indicates that, the assumption that the intra-household variation in dietary customs and physical activity levels should be smaller than the inter-household variation, the third assumption, is not necessarily true.

2.4.2. Background to the double burden within households in West Java: a summary

On the basis of the examination of the three assumptions for the emergence of the double burden within households in West Java, it is possible that the following "failures" may have emerged in the process of nutrition transition: a lack of association between individual socioeconomic status and/or lifestyle factors, and nutritional intake and physical activity patterns, especially in Bandung; and large individual variations in nutritional intake patterns and physical activity levels within households. In a wider perspective, this suggests that the changes related to the nutrition transition have loosened the ties of household members in terms of their diet and activity and resulted in them having their own food intake and physical activity patterns that are more independent from other members. This has led to a greater disparity in nutritional status within households.

2.4.3. Household and individual predictors of the households with a double burden

Given the emergence of a background that allows the existence of households with a double burden, the next question is what type of households came to have a double burden. To determine the distinctive characteristics of households with a double burden, they were compared with households in the other categories. This comparative analysis showed that households with a double burden were more likely to have a larger number of members, and household heads with a higher education. A larger number of household members would be expected to be related to a higher possibility of under- and overnutrition co-existing in the same household. The observed association with the household heads' educational level was consistent with the results that Lee et al. (2012) obtained in Guatemala and to those of Vaezghasemi et al. (2014) in Indonesia, but conflicts with Oddo et al.'s (2012) results from rural Indonesia and with the results from Jehn and Brewis's (2009) analysis of 18 countries. As discussed in the first chapter, the effects of education can interact with household wealth and cannot be interpreted easily. In this case, the interaction may also be related to the higher level of education in Bandung.

The results of the individual-level logistic regression analyses revealed that distinctive characteristics were present for overnourished individuals in households with a double burden: overnourished individuals in double burden households were more likely to be adult, less active and obtained less energy from carbohydrates, fat and grain/tubers, compared to their counterparts in overnourished households. There were no significant differences found between undernourished individuals in undernourished households and households with a double burden. Therefore, a plausible scenario is that double burden households emerged from undernourished households when one or more of the adult members became less active, and got less energy from carbohydrates or fat. Those individuals became overweight, while other household members remained underweight. The finding from the household level analysis suggests that such households were more likely to have a head with a higher educational background. The undernourished members in the double burden households did not experience the nutritional transition possibly because of the social norms in Sundanese societies (i.e., solitary meals and parents' less intensive intervention in the area of children's diet, independent of daily activity).

These differences between malnourished individuals in double burden households and those in the other household categories may be key when it comes to

understanding the within-household interactions and dynamics between household members, which might cause the coexistence of two different states of malnutrition. As differences were not only found in food intake but also in physical activity, future studies should also focus on this in addition to nutritional/dietary intake. Moreover, the energy contribution from grain/tubers, that is, staple food, also seems to play an important role.

2.4.4. Strengths and limitations

This study has several limitations. Due to the purposive sampling, the representativeness of population was limited, resulting in reduced generalizability of the results. This is related to the small size of the core sample in Bandung and thus the disparity in the sample size in the two areas. Also, it was not possible to make a direct comparison between energy intake and expenditure, i.e., the assessment of energy balance, due to the difference in the accuracy of the measurements of nutritional intake and physical activity, even though they were put into the regression models simultaneously. Another limitation related to the methodology is the possible bias in information collected by weighed dietary records. As mentioned before, the possibility of underreporting of dietary intake among overnourished individuals cannot be ruled out.

The difference in accuracy of the records by participant and household is also unknown. It may depend on mothers since mothers wrote their household members' recording sheets, and therefore it is not appropriate to compare the dietary scores to those of physical activity measured by accelerometer independently on individuals. Seasonal effects should be mentioned in this context as well. The field surveys in both areas were conducted in the dry season and therefore the participants' physical activity and food intake were unknown in the rainy season. These might differ from those in the dry season and therefore might have affected the participants' current nutritional status.

Nevertheless the concurrent measurement of physical activity and food intake is one of the strengths of this study. Another was our use of accelerometers to accurately measure physical activity levels. Moreover, even though it is less accurate, a weighed dietary record is subject to fewer biases including recall bias, which is common for other dietary survey methods. In addition, by conducting surveys in two areas in the same Sundanese-majority area, but with different levels of development, it was possible to compare physical activity and food intake patterns and their determinants.

2.4.5. Conclusion

In conclusion, the results of my field surveys in West Java indicated that double burden households, which have been viewed as “paradoxical”, are understood reasonably on the condition that: nutritional and dietary patterns and physical activity levels were not determined by household income, occupation, education and other socioeconomic and lifestyle factors; and that members in the same household did not have similar nutritional and dietary patterns and physical activity levels due to the shared resources and circumstances. This suggests that the changes related to the nutrition transition have loosened the ties of household members in terms of their diet and activity and that they now have their own patterns of food intake and physical activity that are more independent from those of the other members. This has resulted in a greater disparity in nutritional status within households.

Since overnourished individuals in households with a double burden had lower physical activity levels and obtained less energy from staple foods compared to overnourished individuals in the other household types, further investigation is needed and should focus on within-household interactions and the dynamics of resource allocation and physical activity.

General Conclusion

In the first chapter, I conducted a review of earlier articles about the double burden of malnutrition within households. To the best of my knowledge, there have been no previous review articles primarily about this phenomenon published in scientific journals.

This review revealed several research gaps. In particular, the comparability between studies was poor. Even though the number of articles about the double burden of malnutrition within households has been increasing, it was difficult to compare the reported prevalence figures due to differences in nutritional indicators and cutoffs, or the combination of malnourished individuals across studies. Another gap related to the regions and countries studied. While African countries and low-income countries were frequently studied, studies about Asian countries and higher income countries were lacking.

Despite these research gaps, it was possible to determine the trend in the national prevalence and associated factors. The prevalence of double burden mother-child pairs had increased in 24 of the 35 countries that were assessed in a

comparative way. Plotting by the country's per capita GNI indicated that the prevalence was higher in lower middle-income countries.

Regarding associated factors, the most frequently examined ones were urban residence, household income and maternal or household heads' education. When examining these there was some indication that households with a double burden have certain characteristics in common such as urban residence and higher income, although the results concerning education were mixed. However, neither urban residence, higher income nor education directly brings about undernutrition or overnutrition. Rather, it is the poor quality of nutritional intake and/or the imbalance between energy intake and expenditure, and they are strongly defined by dietary intake and physical activity. Therefore, examining diet and physical activity as intermediate factors between household and individual characteristics and nutritional status, should be helpful for understanding the double burden of malnutrition within households.

Based on this review, I conducted field surveys in West Java, Indonesia, focusing on the participants' dietary intake and physical activity levels. An analysis of the data collected in urban and rural areas indicated that double burden households, which have been viewed as "paradoxical", can be understood reasonably well when it is recognized that: nutritional and dietary patterns and physical activity levels are not

necessarily determined by household income, occupation, education and other socioeconomic and lifestyle factors; and that members in the same household do not always have similar nutritional and dietary patterns and physical activity levels. This suggests that the changes related to the nutrition transition have weakened the cohesiveness of household members in terms of their diet and activity and that individual household members now have their own, more independent patterns of food intake and physical activity, which has resulted in a greater disparity in nutritional status within households.

As overnourished individuals in double burden households had lower physical activity levels and got less energy from staple foods, future research should examine within-household interactions, and the dynamics of resource allocation and physical activity.

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Table 1-A. Characteristics of included literatures' analysis

Ref. No.	First author	Year of publishment	Country	Datasource	Year of datasource	No. of sampled HHs/pairs	Combination of UN and ON	Adult Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	Child Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	Reference dataset[a]
1	Sawaya AL	1995	Brazil	Original survey	1990-1991	NA	malnourished child & obese adult	18y-	-	BMI>27.8	-10y	<90% of expected WAZ	-	NCHS reference
2	Doak CM	2000	Brazil, China and Russia	National representative survey	1989-1996	varied	at least 1 OW person & 1 UW person	18y- (17y- for Brazil)	BMI<18.5	BMI≧25	2-18y	equivalent BMI centile to the adult BMI of 18.5	equivalent BMI centile to the adult BMI of 25	IOTF BMI reference
3	Doak CM	2002	China	Survey representative of 8 provinces	1993	3340	at least 1 UW person & at least 1 OW person	NA	BMI<18.5	BMI≧25	6-18y	equivalent BMI centile to the adult BMI of 18.5	equivalent BMI centile to the adult BMI of 25	IOTF BMI reference
4	Angeles-Agdeppa I	2003	Philippines	Original survey	NA	376	UW child & OW mother	NA	-	BMI≧25	33-83mo	WAZ≦-2	-	NCHS/WHO reference
5	Khor GL	2003	Malaysia	Original survey	NA	140	UW child & OW mother	20y-	-	BMI≧25	1-6y	WAZ<-1	-	NCHS reference
6	Doak CM	2005	7 countries	National representative survey	1988-1996	varied	at least 1 UW person & 1 OW person	18y-	BMI<18.5	BMI≧25	2-18y	lower than equivalent BMI centile to adult's 18.5	higher than equivalent BMI centile to adult's 25	IOTF BMI reference
7	Garrett JL	2005	36 countries	DHS	1991-1998	varied	stunted child & OW mother	18y-	-	BMI>25	6-60mo	HAZ<-2	-	WHO/NCHS /CDC reference
8	Garrett JL	2005	42 countries	DHS	1992-2001	NA	stunted child & OW mother	18y-	-	BMI>25	6-60mo	HAZ<-2	-	WHO/NCHS /CDC reference
9	Raphael D	2005	Haiti	Original survey	2003	203	stunted/wasted child & OW/OB mother	NA	-	BMI>25	6-59mo	WHZ<-2 or HAZ<-2	-	NCHS reference
10	Barquerra S	2007	Mexico	National representative survey	1998-1999	5983	stunted child & OW mother	12-49y	-	BMI>25	-5y	HAZ<-2	-	WHO/NCHS /CDC reference

Table 1-A. Characteristics of included literatures' analysis (continued)

Ref. No.	First author	Year of publishment	Country	Datasource	Year of datasource	No. of sampled HHs/pairs	Combination of UN and ON	Adult			Child			Reference dataset[a]
								Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	
							stunted child & OB mother	12-49y	-	BMI>29.9	-5y	HAZ<-2	-	WHO/NCHS /CDC reference
							stunted child & WC>88cm mother	12-49y	-	WC>88cm	-5y	HAZ<-2	-	WHO/NCHS /CDC reference
							stunted child & WHR≧0.85 mother	12-49y	-	WHR≧0.85	-5y	HAZ<-2	-	WHO/NCHS /CDC reference
11	Jehn M	2009	18 countries	DHS	1998-2004	varied	UW child & OW mother	13-49y	-	BMI≧25	3-5y	WAZ<-2	-	WHO reference
12	Saibul N	2009	Malaysia	Original survey	2002-2005	182	UW child & OW mother	17-49y	-	BMI≧25	1.2-8.5y	WAZ<-2	-	WHO and NCHS/WHO reference
13	Lee J	2010	Guatemala	National representative survey	2000	2261	stunted child & OW mother	18-49y	-	BMI>25	12-60mo	HAZ<-2	-	WHO reference
14	Dieffenbach S	2012	54 countries	DHS	1991-2009	varied	stunted child & OW mother	NA	-	BMI≧25	2-5y	HAZ≦-2	-	WHO reference
15	Dop MC	2012	Cape Verde	National representative survey	2001-2002	1571	at least 1 OW person & 1 UW person	18y-	BMI<18.5	BMI≧25	-18y	WHZ≦-2 for -10y; BAZ≦5%tile for 10-17.9y	WHZ≧2 for -10y; BAZ≧85%tile for 10-17.9y	WHO and WHO/NCHS reference
16	Grijalva-Eternod CS	2012	Algeria	Original survey	2010	1066	at least 1 child or woman of UN & at least 1 child or woman of OW	15-49y	HAZ<-2 or BMI<18.5	BMI≧25	-5y	WHZ<-2 or HAZ<-2 or WAZ<-2 or oedema	BAZ>2	WHO reference
							at least 1 child or woman of UN & at least 1 child or woman of OW	15-49y	HAZ<-2 or BMI<18.5	WC≧80	-5y	WHZ<-2 or HAZ<-2 or WAZ<-2 or oedema	BAZ>2	WHO reference

Table 1-A. Characteristics of included literatures' analysis (continued)

Ref. No.	First author	Year of publishment	Country	Datasource	Year of datasource	No. of sampled HHs/pairs	Combination of UN and ON	Adult			Child			Reference dataset[a]
								Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	
17	Lee J	2012	Guatemala	National representative survey	2000	2492	stunted child & OW mother	18-49y	-	BMI≧25	6-60mo	HAZ<-2	-	WHO reference
18	Oddo VM	2012	Bangladesh and Indonesia	National representative survey	2000-2006	varied	stunted child & OW mother	NA	-	BMI≧25	6-59mo	HAZ<-2	-	WHO reference
							stunted child & OW mother	NA	-	BMI≧23	6-59mo	HAZ<-2	-	WHO reference
19	Verela-Silva MI	2012	Mexico	Original survey	2010	58	stunted child & OW/OB mother	NA (34.3y on average)	-	BMI>25	NA (8.4y on average)	HAZ<-2	-	a reference based on NHANES
							stunted child & OW/OB mother	NA (34.3y on average)	-	BMI>25	NA (8.4y on average)	HAZ<5%tile	-	a reference based on NHANES
20	Ihab AN	2013	Malaysia	Original survey	NA	223	UW child & OW mother	18-55y	-	BMI>25	2-12y	WAZ<-1	-	NCHS reference
21	Ponce MC	2013	Venezuela	Original survey	2010	41	at least 1 OW/OB adult & at leat 1 stuted child	19y-	-	BMI>25	0-19y	HAZ<-2	-	WHO reference
22	Roemling C	2013	Indonesia	National representative survey	1993-2007	varied	at least 1 UW person & 1 OW person	19y-	BMI<18.5	BMI>23	2-19y	BAZ<-2	BAZ>1	WHO reference?
23	Bassete MN	2014	Algentina	Original survey	2005	136	at least 1 stunting child & OW mother	NA	-	BMI≧25	2-18y	HAZ<-2	-	WHO reference
24	Conde WL	2014	Brazil	DHS/National representative surveys	1974-2009 (2006-2007?)	4390	stunted child & OW mother	NA	-	BMI≧25	-5y	HAZ<-2	-	WHO reference

Table 1-A. Characteristics of included literatures' analysis (continued)

Ref. No.	First author	Year of publishment	Country	Datasource	Year of datasource	No. of sampled HHs/pairs	Combination of UN and ON	Adult			Child			Reference dataset[a]
								Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	
25	Fraire WB	2014	Ecuador	National representative survey	2012	8078	stunted child & OW/OB mother	-59y	-	BAZ>1 for -20y; BMI≧25 for 20y-	-5y	HAZ<-2	-	WHO reference
26	Kroker-Lobos MF	2014	Mexico	National representative survey	2012	4777	stunted child & OW/OB mother	-49y	-	BAZ>1 for -20y; BMI≧25 for 21y-	-5y	HAZ<-2	-	WHO reference
27	Leroy JL	2014	Mexico	Original survey	2003-2004	1547	stunted child & OW mother	18-49y	-	BMI>25	0-5y	HAZ<-2	-	NA
28	Ramirez-Zea M	2014	Guatemala	National representative survey	2008	9320	stunted child & OW/OB mother	15-49y	-	BMI≧25	0-59mo	HAZ<-2	-	WHO reference
29	Sarmiento OL	2014	Colombia	National representative survey	2010	10317	at least 1 stunted child & OW/OB mother	18-49y	-	BAZ≧2 for -19y; BMI≧25 for 20y-	-5y	HAZ<-2	-	WHO reference
30	Severi C	2014	Uruguay	National representative survey	2004-2011	1532	stunted child & OW/OB mother	NA	-	BMI>25	6y	HAZ<-2	-	WHO reference
31	Vaezghasemi M	2014	Indonesia	National representative survey	2007-2008	9743	at least 1 UW person & 1 OW person	18y-	BMI<18.5	BMI≧25	2-18y	lower than BMI cut-off corresponding to adult's 18.5	higher than BMI cut-off corresponding to adult's 25	six countries' nationally representative surveys
32	Wojcicki JM	2014	27 countries	DHS	2000-2010	NA	UW child & OB mother	NA	-	BMI≧30	-5y	WAZ<-2	-	NA
							stunted child & OB mother	NA	-	BMI≧30	-5y	HAZ<-2	-	NA
33	Aitsi-Selmi A	2015	Egypt	DHS	1992-2008	varied	stunted child & OB mother	15-49y	-	BMI≧30	0-3y	HAZ<-2	-	NCHS reference

Table 1-A. Characteristics of included literatures' analysis (continued)

Ref. No.	First author	Year of publishment	Country	Datasource	Year of datasource	No. of sampled HHs/pairs	Combination of UN and ON	Adult			Child			Reference dataset[a]
								Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	Age range	Indicator and cut-off for UN	Indicator and cut-off for ON	
34	Kimani-Murage EW	2015	Kenya	Demographic surveillance	2010	6308	stunted child & OW/OB	NA	-	BMI≧25	-5y	HAZ<-2	-	WHO reference
						6384	UW child & OW/OB	NA	-	BMI≧25	-5y	WAZ<-2	-	WHO reference
						6306	wasted child & OW/OB	NA	-	BMI≧25	-5y	WHZ<-2	-	WHO reference
35	Parra DC	2015	Colombia	National representative survey	2000-2010	varied	at least 1 stunted child & OW/OB	NA	BMI<18.5	BMI≧25	-5y	HAZ<-2	BAZ>2	WHO reference
							at least 1 stunted child & OW/OB mother, or at least 1 OW/OB child & UW mother	NA	BMI<18.5	BMI≧25	-5y	HAZ<-2	BAZ>2	WHO reference

[a]Reference dataset indicates the dataset used for calculation of z-scores in the study. If the author(s) did not mention, the colums are filled with "NA". BAZ: body-mass-index z-score. BMI: body mass index. CDC: centers for disease control. DHS: demographic and health surveys. HAZ; height-for-age z-score. IOTF: international obesity task force. NA: not available (not mentioned in the article). NCHS: national center for health statistics. NHNES: national health and nutrition examination survey. OB: obese. ON: overnutrition. OW: overweight. UN: undernutrition. UW: underweight. WAZ: weight-for-age z-score. WC: waist circumference. WHO: world health organization. WHR: waist-to-hip ratio. WHZ: weight-for-height z-score.

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators

Country	(note)	Year	Prevalence (%)	Ref. No.
Stunted child and overweight or obese mother pairs				
Armenia		2005	3.2	14
Azerbaijan		2006	8.5	14
Bangladesh		1996	0.6	14
		1999	1.1	
		2004	1.4	
		2007	1.7	
		1996	1.3	7
		2000	1.0	8
	(rural, BMI≧23)	2003-2006	3.7	18
	(rural)	2003-2006	1.4	
Benin		1996	1.2	14
		2001	2.8	
		2006	3.5	
		1996	2.0	7
		2000	3.5	8
Bolivia		1994	7.3	14
		1998	9.4	
		2003	9.4	
		2008	7.9	
		1998	11.0	7
		1998	11.5	8
Brazil		1996	2.8	14
		1996	2.7	7
		1996	2.6	8
		2006-2007	2.6	24
Burkina Faso		1992	1.9	7
		1993	1.5	14
		1998	1.7	
		2003	1.5	
		1999	1.9	8
Cambodia		2000	1.8	14
		2005	2.9	
		2000	2.5	8
Cameroon		1997	5.4	7
		1998	4.0	14
		2004	5.3	
		1998	4.8	8
Central African Republic		1994	1.4	14
		1994	2.5	7
		1994	2.2	8
Chad		1996	1.8	14
		2003	3.0	
		1996	1.8	7
		1996	1.8	8
Colombia		1995	3.6	14
		2005	3.6	
		1995	5.0	7
		2000	4.2	8

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country (note)	Year	Prevalence (%)	Ref. No.
Comoros	1996	3.5	14
	1996	5.5	7
	1996	5.6	8
Congo	2005	4.4	14
Cote d'Ivoire	1994	2.0	14
	1998	3.1	
	1994	2.7	7
	1998	2.5	8
Dominican Republic	1991	3.5	14
	1996	2.2	
	1991	2.2	7
	1996	2.2	8
DR Congo	2007	2.9	14
Ecuador	2012	13.1	25
Egypt	1992	11.2	14
	1995	11.6	
	2000	10.9	
	2003	8.8	
	2005	13.6	
	2008	16.0	
	1995	14.0	7
	2000	12.4	8
Ethiopia	2000	0.7	14
	2005	1.1	
	2000	0.9	8
Gabon	2000	3.3	14
Ghana	1993	1.9	14
	1998	2.1	
	2003	3.4	
	2008	2.7	
	1993	2.2	7
	1998	2.7	8
Guatemala	1995	10.7	14
	1998	14.3	
	1995	13.4	7
	2000	17.9	13
	2000	16.4	17
	2000	16.0	8
	2008	20.0	28
Guinea	2005	2.2	14
	1999	2.9	8
Haiti	1994	2.0	14
	2000	2.6	
	2005	2.0	
	1995	2.0	7
	2000	2.8	8
Honduras	2005	7.9	14
India	1998	1.3	14
	2005	2.3	
	1998	1.2	8

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country	(note)	Year	Prevalence (%)	Ref. No.
Indonesia	(rural, BM≧23)	2000-2003	11.1	18
	(rural)	2000-2003	5.8	
Jordan		1997	4.1	14
		2002	5.7	
		2007	7.1	
		2009	4.3	
Kazakhstan		1995	2.7	14
		1999	1.4	
		1995	2.6	7
		1995	2.7	8
Kenya		1993	3.0	14
		1998	2.5	
		2003	3.3	
		2008	4.7	
		1998	2.6	7
		1998	2.4	8
	(urban poor)	2010	13.1	34
Kyrgyz Republic		1997	3.9	14
		1997	4.4	7
		1997	4.5	8
Lesotho		2004	11.7	14
Madagascar		1997	1.1	14
		2003	2.3	
		2008	1.7	
		1997	1.4	7
		1997	1.1	8
Malawi		1992	3.7	14
		2000	3.9	
		2004	3.8	
		1992	4.6	7
		2000	4.8	8
Mali		1995	1.5	14
		2001	2.7	
		2006	4.5	
		1995	2.1	7
		2001	4.0	8
Mexico		1998-1999	5.8	10
		2012	8.4	26
	(urban)	2010	15.5	19
	(urban, HAZ<5th percentile)	2010	27.6	
Moldova		2005	2.7	14
Morocco		1992	4.8	14
		2003	5.4	
		1992	5.2	7
		1992	5.8	8
Mozambique		1997	1.5	14
		2003	2.8	
		1997	2.5	7
		1997	2.2	8

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country (note)	Year	Prevalence (%)	Ref. No.
Namibia	1992	3.0	14
	2006	4.5	
	1992	3.7	7
	1992	3.8	8
Nepal	1996	0.5	14
	2001	1.4	
	2006	0.9	
	1996	0.6	7
	2001	1.5	8
Nicaragua	1996	8.2	7
	1998	6.7	14
	2001	5.9	
	2001	6.9	8
Niger	1992	2.2	14
	1998	2.1	
	2006	4.3	
	1998	3.3	7
	1998	2.1	8
Nigeria	1999	7.3	14
	2003	4.4	
	2008	5.2	
	1999	8.3	8
Peru	1991	8.1	14
	1996	8.3	
	2000	8.9	
	2004	8.5	
	1996	9.8	7
	2000	9.6	8
Rwanda	2000	4.0	14
	2005	3.2	
	2000	5.6	8
Senegal	1992	1.9	14
	2005	2.0	
	1992	2.2	7
	1992	2.5	8
Sierra Leone	2008	7.1	14
Swaziland	2006	10.3	14
Tanzania	1991	2.6	14
	1996	2.5	
	2004	3.3	
	1996	4.8	7
	1996	4.5	8
Togo	1998	1.5	14
	1998	2.0	7
	1998	1.8	8
Turkey	1993	7.3	14
	1998	6.9	

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country (note)	Year	Prevalence (%)	Ref. No.
Uganda	1995	2.5	14
	2000	3.0	
	2006	1.9	
	1995	3.1	7
	2000	3.1	8
Uruguay	2004-2006	6.3	30
Uzbekistan	1996	3.9	14
	1996	5.5	7
	1996	5.5	8
Zambia	1992	3.7	14
	1996	3.1	
	2001	3.3	
	2007	4.8	
	1996	4.3	7
	1996	4.5	8
Zimbabwe	1994	3.4	14
	1999	4.1	
	2005	5.0	
	1994	4.3	7
	1999	5.9	8
Stunted child and obese mother pairs			
Benin	2004	1.6	32
Burkina Faso	2003	0.8	32
Congo	2005	1.5	32
Egypt	1992-1995	4.1	33
	2005-2008	5.6	
Gabon	2000	1.2	32
Ghana	2003	2.9	32
	2008	0.7	
Guinea	2003	0.3	32
Kenya	2003	1.7	32
Lesotho	2004	4.9	32
	2009	4.4	
Liberia	2007	1.3	32
Madagascar	2003	0.1	32
Malawi	2001	0.5	32
Mali	2001	0.5	32
	2006	1.0	
Mexico	1998-1999	2.2	10
Mozambique	2003	0.4	32
Namibia	2007	1.9	32
Niger	2008	0.5	32
Nigeria	2003	1.5	32
	2008	1.8	
Rwanda	2000	0.5	32
Sao Tome	2009	4.3	32
Senegal	2005	0.7	32
Sierra Leone	2006	2.9	32
Swaziland	2006	4.5	32

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country	(note)	Year	Prevalence (%)	Ref. No.
Tanzania		2005	0.7	32
		2010	0.8	
Uganda		2006	0.7	32
Zambia		2002	0.6	32
		2007	0.9	
Zimbabwe		2005	1.4	32
Underweight child and overweight or obese mother pairs				
Bangladesh		2004	1.5	11
Benin		2001	0.7	11
Bolivia		2003	1.5	11
Burkina Faso		2003	0.7	11
Colombia		2000	1.7	11
Egypt		2000	1.2	11
Ethiopia		2000	0.3	11
Ghana		2003	2.4	11
Guatemala		1998-1999	5.3	11
Haiti		2000	1.0	11
Kenya		2010	2.7	34
Kenya		2003	1.4	11
Malawi		2000	0.8	11
Malaysia	(rural)	2002[a]	38.6	5
	(village)	2002-2005	25.8	12
	(rural)	2003[a]	8.2	20
Mexico	(rural)	2003-2004	9.6	27
Morocco		2003-2004	3.1	11
Nicaragua		2001	2.2	11
Nigeria		2003	2.5	11
Peru		2000	1.7	11
Philippines	(urban poor)	2012[b]	29.6	4
Uganda		2000-2001	0.9	11
Zambia		2001-2002	1.3	11
Underweight child and obese mother pairs				
Benin		2004	0.0	32
Burkina Faso		2003	0.2	32
Congo		2005	0.3	32
Gabon		2000	0.2	32
Ghana		2003	0.5	32
		2008	0.3	
Guinea		2003	0.4	32
Kenya		2003	0.3	32
Lesotho		2004	0.7	32
		2009	0.3	
Liberia		2007	0.2	32
Madagascar		2003	0.0	32
Malawi		2000	0.0	32
Mali		2001	0.2	32
		2006	0.5	

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country (note)	Year	Prevalence (%)	Ref. No.
Mozambique	2003	0.0	32
Namibia	2007	0.5	32
Niger	2008	0.1	32
Nigeria	2003	0.6	32
	2008	0.6	
Rwanda	2000	0.0	32
Sao Tome	2009	1.3	32
Senegal	2005	0.3	32
Sierra Leone	2006	0.0	32
Swaziland	2006	4.3	32
Tanzania	2005	0.1	32
	2010	0.0	
Uganda	2006	0.1	32
Zambia	2002	0.0	32
	2007	0.0	
Zimbabwe	2005	0.2	32
Wasted child and overweight or obese mother pairs			
Kenya	2010	0.6	34
Wasted child and obese mother pairs			
Benin	2004	0.2	32
Burkina Faso	2003	0.0	32
Congo	2005	0.4	32
Gabon	2000	0.5	32
Ghana	2003	2.8	32
	2008	0.6	
Guinea	2003	0.4	32
Kenya	2003	1.2	32
Lesotho	2004	2.1	32
	2009	1.7	
Liberia	2007	0.8	32
Madagascar	2003	0.1	32
Malawi	2000	0.2	32
Mali	2001	0.4	32
	2006	0.9	
Mozambique	2003	0.2	32
Namibia	2007	1.4	32
Niger	2008	0.4	32
Nigeria	2003	0.7	32
	2008	1.1	
Rwanda	2000	0.2	32
Sao Tome	2009	2.4	32
Senegal	2005	0.5	32
Sierra Leone	2006	2.2	32
Swaziland	2006	9.5	32
Tanzania	2005	2.9	32
	2010	4.9	
Uganda	2006	0.4	32
Zambia	2002	0.2	32
	2006	0.3	

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country (note)	Year	Prevalence (%)	Ref. No.
Zimbabwe	2005	0.5	32
Stunted or wasted child and overweight or obese mother pairs			
Haiti (urban)	2003	14.3	9
Stunted child and the mother of waist>88cm			
Mexico	1998-1999	2.6	10
Stunted child and the mother of waist-hip-ratio ≧0.85			
Mexico	1998-1999	6.7	10
Malnourished child and obese adult			
Brazil	1990-1991	9.0	1
At least one overweight or obese adult and at least one stunted child			
Venezuela	2010	26.8	21
At least one underweight member and at least one overweight or obese member			
Brazil	1989	10.9	6
	1989	10.9	2
Cape Verde	2001-2002	13.9	15
China	1993	8.3	6
	1993	8.3	3
	1993	8.3	2
Indonesia	1993	11.1	22
	1997	16.3	
	2000	16.8	
	2007	16.1	
	1993-1994	11.0	6
	2007-2008	19.9	31
Russia	1996	7.8	6
	1996	7.8	2
The Kyrgyz Republic	1993	15.5	6
The United States	1988-1994	5.4	6
Viet Nam	1992-1993	3.7	6
At least one stunted child and overweight or obese mother			
Argentine	2005	11.8	23
Colombia	2010	5.1	29
	2000	7.2	35
	2005	6.6	
	2010	6.2	
At least one stunted child and overweight or obese mother, or the opposite			
Colombia	2000	7.3	35
	2005	6.7	
	2010	6.3	

Table 1-B. Reported prevalence of the double burden households/pairs by the combination of under- and overnourished persons and nutritional indicators (continued)

Country	(note)	Year	Prevalence (%)	Ref. No.
At least one child or woman of undernutrition and at least one child or woman of overweight or obese				
Algeria	(refugees)	2010	24.7	16
	(refugees, WC≧80cm)	2010	28.3	

[a]year of acceptance of the paper. [b]year of submission of the paper. BMI: body mass index. Obesity: Having a body mass index of 30.0 or more. Overweight: In adults, Having a body mass index between 25.0 and 30.0 unless otherwise noted. In children, it depends on studies (see Table 1-A). Stunting: Below minus two standard deviations from mean height for age of the reference population. Underweight: In adults having a body mass index below 18.5. In children, below minus two standard deviations from mean weight for height or body mass index for age of the reference population. Wasting: Below minus two standard deviations from mean weight for age of the reference population. WC: waist circumference.

Table 1-C. Association between the double burden within households and frequently assessed factors: urban residence, income and household heads' education

Ref. No.	Country	Comparison with other HH category				Comparison/regression of prevalence
		vs. Normal HHs/pairs	vs. UN HHs/pairs	vs. ON HHs/pairs	vs. All other HHs/pairs	
2	Brazil	urban residence (p), higher income (p)	urban residence (p), higher income (p)	urban residence (p), higher income (n)		
	China	urban residence (p), higher income (p)	urban residence (p), higher income (p)	(NS: urban residence, income)		
	Russia	(NS: urban residence, income)	(NS: urban residence, income)	urban residence (p), higher income (n)		
3	China	urban residence (p), (NS: income)	urban residence (p), higher income (p)	(NS: urban residence, income)		
4	Philippines	maternal higher education (n), (NS: income)				
6	Brazil		urban residence (p), higher income (p),	urban residence (p), higher income (n)		
	China		urban residence (p), higher income (p),	(NS: urban residence, income)		
	Indonesia		urban residence (p), higher income (p),	(NS: urban residence, income)		
	The Kyrgyz Republic		urban residence (p), higher income (p),	(NS: urban residence, income)		
	Russia		(NS: urban residence, income)	urban residence (p) higher income (n)		
	Viet Nam		urban residence (p), higher income (p),	(NS: urban residence, income)		
	The United States		urban residence (p), higher income (p),	(NS: urban residence, income)		
7	Benin					(NS: level of urbanizatioin)
8	Benin					(NS: level of urbanization)

Table 1-C. Association between the double burden within households and frequently assessed factors: urban residence, income and household heads' education (continued)

Ref. No.	Country	Comparison with other HH category (reference)				Comparison/regression of prevalence
		vs. Normal HHs/pairs	vs. UN HHs/pairs	vs. ON HHs/pairs	vs. All other HHs/pairs	
9	Haiti	(NS: HH SES (score created from parents education, income, housing condition)	(NS: HH SES (score created from parents education, income, housing condition)	(NS: HH SES (score created from parents education, income, housing condition)		
11	18 countries (UW child-OW mother)	urban residence (p), maternal higher education (n)				
	18 countries (Stunted child-OW mother)	maternal higher education (n), (NS: urban residence)				
12	Malaysia				(NS: HH income/income per capita, maternal education)	
13	Guatemala	(NS: urban residence)				
15	Cape Verde		urban residence (p)	urban residence (p)		
17	Guatemala				maternal higher education (p) (NS: urban residence)	
18	Indonesia (rural)				maternal higher education (n), higher per capita expenditure (p)	
	Bangladesh (rural)				higher per capita expenditure (p), maternal higher education (p)	
20	Malaysia	(NS: inome, per capita income, maternal education)				

Table 1-C. Association between the double burden within households and frequently assessed factors: urban residence, income and household heads' education (continued)

Ref. No.	Country	Comparison with other HH category (reference)				Comparison/regression of prevalence
		vs. Normal HHs/pairs	vs. UN HHs/pairs	vs. ON HHs/pairs	vs. All other HHs/pairs	
22	Indonesia	urban residence (p)		urban residence (p), (NS: HH head's education)	urban residence (n)	
23	Algentina				(NS: HH income)	
27	Mexico					(NS: maternal education)
33	Egypt	(NS: urban residence, maternal education)				
31	Indonesia				urban residence (p), HH head's higher education (p)	
35	Colombia					urban residence (n)

"(p)" indicates positive association. "(n)" indicates negative association. DBHH: double burden household. HH: household. NS: not significant. ON: overnutrition. OW: overweight. SES: socioeconomic status. UN: undernutrition. UW: underweight.

Table 2-A. Classification of individual nutritional status

Age	HAZ	WAZ	WHZ	BAZ	BMI
Undernutrition					
~5 years (60 months)	below -2	below -2	below -2	below -2	unavailable
5~19 years (228 months)	below -2	below -2	unavailable	below -2	unavailable
19 years~	unavailable				below 18.5
Overnutrition					
~5 years (60 months)	-	-	above +2	above +1	unavailable
5~19 years (228 months)	-	-	unavailable	above +1	unavailable
19 years~	unavailable				25.0 or higher

BAZ: body mass index-for-age z-score. BMI: body mass index. HAZ: height-for-age z-score. WAZ: weight-for-age z-score. WHZ: weight-for-height z-score.

Table 2-B. Characteristics of households studied in Bandung and Sumedang

	Bandung		Sumedang	
	Whole sapmles	Core sapmles	Whole sapmles	Core sapmles
Number of households	66	19	79	75
Number of household members (mean (SD))	4.1 (1.7)	4.8 (2.5)	2.7 (1.1)	2.7 (1.1)
Per capia monthly income (1000 IDR; median)	625.0	683.3	385.4	400.0
(25-75th percentile)	(400.0-933.3)	(325.0-1107.1)	(135.0-733.3)	(145.0-733.3)
Nutritional status category (n (%))				
Double burden	24 (36.4)	11 (57.9)	13 (16.5)	13 (17.3)
Normal	8 (12.1)	1 (5.3)	21 (26.6)	20 (26.7)
Overnutrition	26 (39.4)	7 (36.8)	24 (30.4)	23 (30.7)
Undernutrition	8 (12.1)	0 (0.0)	21 (26.6)	19 (25.3)

IDR: Indonesia rupiah

Table 2-C. The number of combinations of under- and overnourished individuals in the households with a double burden of malnutrition

Undernutrition	Overnutrition	Bandung	Sumedang	Total
child(ren)	mother	10	6	16
child(ren)	father mother	3		6
child	grandmother	1	1	2
child	father grandmother	2		2
child	child mother		2	2
2 children	mother father adult man grandmother	1		1
child father	grandmother	1		1
2 children mother	father	1		1
father	child	1		1
2 children (adult)	mother mother's sister	1		1
2 children mother	mother's sister	1		1
child	child mother father	1		1
child	2 children father mother mother's brother	1		1
father	mother		1	1
Total		24	13	37

Table 2-D (a). Individual characteristics of subjects by area, sex and adult/child status of "whole samples"

	Bandung (66 households)								Sumedang (79 households)							
	Adults (20y-)				Children (2-19y)				Adults (20y-)				Children (2-19y)			
	Males		Females		Males		Females		Males		Females		Males		Females	
Number of individuals	90		92		43		45		77		84		28		27	
Age (year, mean (SD))	41.2	(13.3)	43.1	(15.0)	10.0	(5.6)	9.9	(4.9)	47.0	(17.8)	47.1	(17.0)	10.9	(5.0)	9.4	(4.7)
Education (n (%))																
Primary or lower	26	(28.9)	33	(35.9)					48	(62.3)	58	(69.0)				
Junior high school	13	(14.4)	21	(22.8)					13	(16.9)	15	(17.9)				
Higschool or higher	51	(56.7)	38	(41.3)					16	(20.8)	10	(11.9)				
Unknown	0	(0.0)	0	(0.0)					0	(0.0)	1	(1.2)				
Occupation (n (%))																
Housewife	0	(0.0)	54	(58.7)					0	(0.0)	41	(48.8)				
Non-sedentary	59	(65.6)	29	(31.5)					51	(66.2)	21	(25.0)				
Sedentary	5	(5.6)	2	(2.2)					16	(20.8)	11	(13.1)				
Student	1	(1.1)	1	(1.1)					0	(0.0)	0	(0.0)				
Other	25	(27.8)	6	(6.5)					10	(13.0)	11	(13.1)				
Weight (kg; mean (SD))	59.5	(10.8)	57.8	(11.0)	31.6	(17.5)	31.8	(17.5)	55.9	(10.4)	52.1	(12.3)	33.3	(18.2)	31.3	(14.5)
Height (cm; mean (SD))	161.9	(6.7)	149.8	(6.8)	130.1	(29.5)	127.5	(24.2)	159.4	(7.1)	146.8	(6.2)	131.4	(25.9)	126.9	(21.7)
BMI (mean (SD))	22.7	(3.7)	25.8	(4.9)	17.2	(4.3)	17.9	(4.2)	21.9	(3.1)	24.1	(5.2)	17.7	(3.7)	18.2	(3.3)
WAZ (mean (SD))					-1.1	(1.4)	-1.2	(1.1)					-1.6	(0.8)	-0.5	(1.2)
HAZ (mean (SD))					-1.4	(1.1)	-1.5	(1.0)					-2.1	(0.9)	-1.4	(1.2)
WHZ[a] (mean (SD))					-0.4	(1.2)	-0.4	(0.9)					0.5	(0.9)	0.1	(0.8)
BAZ (mean (SD))					-0.7	(1.3)	-0.2	(1.2)					-0.3	(1.3)	0.3	(1.0)
Nutritional status (n (%))																
Normal	64	(71.1)	34	(37.0)	20	(46.5)	23	(51.1)	57	(74.0)	47	(56.0)	8	(28.6)	11	(40.7)
Overnutrition	19	(21.1)	53	(57.6)	3	(7.0)	8	(17.8)	13	(16.9)	31	(36.9)	3	(10.7)	8	(29.6)
Undernutrition	7	(7.8)	5	(5.4)	20	(46.5)	14	(31.1)	7	(9.1)	6	(7.1)	17	(60.7)	8	(29.6)

BAZ: body-mass-index-for-age z-score. BMI: body mass index. HAZ: height-for-age z-score. MET: metabolic equivalent. WAZ: weight-for-age z-score. WHZ: weight-for-height z-score. [a]WHZ was not calculated for children aged more than 60 months.

Table 2-D (b). Individual characteristics of subjects by area, sex and adult/child status of "core samples"

	Bandung (19 households)								Sumedang (75 households)							
	Adults (20y-)				Children (2-19y)				Adults (20y-)				Children (2-19y)			
	Males		Females		Males		Females		Males		Females		Males		Females	
Number of individuals	29		30		15		18		72		80		25		25	
Age (year, mean (SD))	40.3	(11.0)	41.1	(13.9)	8.7	(4.4)	9.3	(5.3)	48.2	(17.6)	47.2	(16.7)	10.8	(5.1)	9.3	(4.4)
Education (n (%))																
Primary or lower	7	(22.6)	6	(20.0)					46	(63.9)	55	(68.8)				
Junior high school	4	(12.9)	6	(20.0)					12	(16.7)	14	(17.5)				
Higschool or higher	18	(58.1)	18	(60.0)					14	(19.4)	10	(12.5)				
Unknown	0	(0.0)	0	(0.0)					0	(0.0)	1	(1.3)				
Occupation (n (%))																
Housewife	0	(0.0)	19	(63.3)					0	(0.0)	39	(48.8)				
Non-sedentary	22	(71.0)	4	(13.3)					49	(65.3)	21	(26.3)				
Sedentary	3	(9.7)	2	(6.7)					16	(21.3)	11	(13.8)				
Student	1	(3.2)	1	(3.3)					0	(0.0)	0	(0.0)				
Other	3	(9.7)	4	(13.3)					7	(9.3)	9	(11.3)				
Weight (kg; mean (SD))	63.0	(8.6)	59.2	(11.2)	28.4	(16.5)	27.9	(14.5)	55.6	(10.7)	52.4	(11.8)	33.8	(18.8)	31.4	(14.4)
Height (cm; mean (SD))	162.1	(7.1)	149.6	(8.0)	124.9	(27.7)	122.0	(23.4)	159.2	(7.3)	146.8	(6.3)	131.3	(26.5)	127.0	(20.5)
BMI (mean (SD))	24.0	(3.2)	26.5	(4.9)	16.5	(3.2)	17.3	(3.3)	21.8	(3.2)	24.2	(5.1)	17.9	(3.8)	18.3	(3.4)
WAZ (mean (SD))					-2.2	(0.6)	-1.0	(0.7)					-1.7	(0.8)	-0.5	(1.2)
HAZ (mean (SD))					-1.7	(0.9)	-1.7	(0.9)					-2.1	(1.0)	-1.4	(1.3)
WHZ[a] (mean (SD))					-0.7	(0.3)	-0.5	(1.1)					0.5	(0.9)	-0.2	(0.5)
BAZ (mean (SD))					-0.6	(1.2)	-0.2	(1.1)					-0.2	(1.4)	0.3	(1.0)
Nutritional status (n (%))																
Normal	18	(62.1)	10	(33.3)	6	(40.0)	8	(44.4)	52	(72.2)	46	(57.5)	7	(28.0)	10	(40.0)
Overnutrition	11	(37.9)	19	(63.3)	2	(13.3)	3	(16.7)	13	(18.1)	30	(37.5)	3	(12.0)	7	(28.0)
Undernutrition	0	(0.0)	1	(3.3)	7	(46.7)	7	(38.9)	7	(9.7)	4	(5.0)	15	(60.0)	8	(32.0)
Physical activity																
MET･h (median)	3.0		2.7		6.0		2.5		4.4		4.0		7.2		4.6	
(25-75th percentile)	(1.9-4.0)		(1.7-3.4)		(3.0-6.7)		(1.5-4.1)		(3.1-7.1)		(2.8-5.3)		(5.4-10.0)		(3.9-6.8)	

Table 2-D (b). Individual characteristics of subjects by area, sex and adult/child status of "core samples" (continued)

	Bandung (19 households)				Sumedang (75 households)			
	Adults (20y-)		Children (2-19y)		Adults (20y-)		Children (2-19y)	
	Males	Females	Males	Females	Males	Females	Males	Females
Nutritional/dietary patterns								
Energy intake (kcal, median)	1938	1582	1280	1324	1698	1411	1400	1377
(25-75th percentile)	(1705-2223)	(1356-1929)	(1167-1735)	(1078-1693)	(1423-1991)	(1108-1623)	(1085-1669)	(1208-1606)
Protein intake (%EI, median)	11.9	12.0	11.5	11.4	9.0	9.3	11.3	10.2
(25-75th percentile)	(10.1-13.1)	(10.8-13.4)	(10.3-12.3)	(9.8-13.1)	(7.7-10.6)	(8.0-10.9)	(9.0-12.9)	(9.9-12.0)
Carbo intake (%EI, median)	60.0	60.4	60.1	60.4	70.8	70.2	60.1	57.2
(25-75th percentile)	(55.1-65.0)	(52.6-65.4)	(51.1-61.5)	(55.5-70.5)	(65.6-76.2)	(65.7-75.9)	(53.9-68.5)	(51.8-63.6)
Fat intake (%EI, median)	26.2	27.1	27.2	26.4	17.7	18.9	25.7	29.1
(25-75th percentile)	(21.7-31.1)	(20.7-31.6)	(23.8-35.5)	(20.4-33.0)	(13.2-22.1)	(13.3-22.6)	(20.5-32.1)	(25.3-36.1)
Grain/tubers (%EI, median)	59.7	60.3	52.8	50.7	66.6	69.5	61.6	51.9
(25-75th percentile)	(53.5-68.4)	(53.4-71.8)	(34.5-59.7)	(42.0-62.8)	(59.5-75.4)	(59.8-76.1)	(49.5-65.8)	(43.7-62.7)
Rice (%EI, median)	47.0	41.2	33.4	35.9	58.8	57.4	38.9	34.9
(25-75th percentile)	(40.4-55.2)	(35.9-53.4)	(26.9-42.4)	(29.6-49.1)	(44.6-67.6)	(44.1-68.5)	(29.2-54.6)	(27.1-40.0)
Vegetables/legumes (%EI, median)	14.5	17.3	7.7	3.8	6.4	6.4	5.2	6.3
(25-75th percentile)	(9.9-19.8)	(8.2-21.4)	(3.5-15.5)	(2.0-7.0)	(3.4-12.6)	(3.2-11.3)	(3.7-10.0)	(3.4-13.8)
Vegetables (%EI, median)	3.3	4.0	1.7	0.6	0.9	1.0	0.2	0.1
(25-75th percentile)	(1.4-6.9)	(2.0-9.7)	(0.7-2.7)	(0.0-2.4)	(0.1-2.8)	(0.0-2.5)	(0.0-1.8)	(0.0-2.9)
Meat/fish (%EI, median)	7.8	7.1	9.1	6.9	4.4	5.4	4.8	10.9
(25-75th percentile)	(4.4-12.8)	(4.0-12.7)	(6.4-18.6)	(3.7-19.1)	(2.8-8.9)	(3.2-9.5)	(0.4-10.3)	(2.0-14.2)
Meat (%EI, median)	6.0	5.3	7.7	6.7	1.8	2.9	4.8	9.2
(25-75th percentile)	(2.2-11.1)	(2.6-10.4)	(6.0-18.2)	(2.9-15.5)	(0.0-4.5)	(0.0-6.4)	(0.0-9.7	(1.0-12.5)
Fish (%EI, median)	1.6	1.2	0.9	0.1	2.0	1.9	0.0	0.4
(25-75th percentile)	(0.0-2.6)	(0.0-2.5)	(0.0-1.7)	(0.0-1.8)	(0.6-3.4)	(0.6-4.1)	(0.0-1.3)	(0.0-1.3)
Egg (%EI, median)	1.4	0.7	1.9	2.7	2.6	2.6	4.8	2.5
(25-75th percentile)	(0.1-2.8)	(0.0-3.2)	(0.0-4.7)	(1.1-4.2)	(1.0-5.4)	(0.0-4.4)	(2.0-8.1)	(0.0-5.5)
Fruits (%EI, median)	0.0	0.7	0.7	0.2	0.0	0.0	0.0	1.5
(25-75th percentile)	(0.0-1.3)	(0.0-2.5)	(0.0-1.8)	(0.0-3.2)	(0.0-1.3)	(0.0-2.9)	(0.0-1.3)	(0.0-4.2)
Dairy products (%EI, median)	0.0	0.0	3.5	5.6	0.0	0.0	0.8	1.4
(25-75th percentile)	(0.0-0.7)	(0.0-0.0)	(0.5-4.6)	(1.0-13.4)	(0.0-0.0	(0.0-0.0)	(0.0-4.4)	(0.0-5.5)

Table 2-D (b). Individual characteristics of subjects by area, sex and adult/child status of "core samples" (continued)

	Bandung (19 households)				Sumedang (75 households)			
	Adults (20y-)		Children (2-19y)		Adults (20y-)		Children (2-19y)	
	Males	Females	Males	Females	Males	Females	Males	Females
Others (%EI, median)	11.8	9.3	19.4	7.3	12.2	9.8	19.2	19.3
(25-75th percentile)	(6.4-16.7)	(5.6-14.9)	(9.4-28.3)	(5.7-24.9)	(5.7-17.8)	(4.4-15.5)	(4.9-27.2)	(10.3-28.2)

BAZ: body-mass-index-for-age z-score. BMI: body mass index. EI: energy intake. HAZ: height-for-age z-score. MET: metabolic equivalent. WAZ: weight-for-age z-score. WHZ: weight-for-height z-score. [a]WHZ was not calculated for children aged more than 60 months.

Table 2-E. Results of a regression analysis for body mass index with age, age-squared, physical activity level and nutritional intake pattern indicators (n=252)

	Model 1		Model 2		Model 3		Model 4	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Age (year)	0.474	<0.01	0.466	<0.01	0.455	<0.01	0.490	<0.01
Age-squared (year^2)	-0.005	<0.01	-0.005	<0.01	-0.005	<0.01	-0.005	<0.01
Sex (female)	2.205	<0.01	2.055	<0.01	1.924	<0.01	1.953	<0.01
Physical activity								
MET･h			-0.119	0.26	-0.080	0.44	-0.017	1.00
Nutritional intake patterns								
EI/BMR					-2.216	<0.01	-2.597	<0.01
Protein intake (%EI)							3.256	0.06
Fat intake (%EI)							10.278	0.01
Constant	12.66	<0.01	13.53	<0.01	16.50	<0.01	13.03	0.16
R^2	0.319		0.323		0.352		0.382	
adujusted R^2	0.311		0.312		0.339		0.364	

MET: metabolic equivalent. EI: energy intake (kcal). BMR: basal metabolic rate (kcal).

Table 2-F. Association between physical activity level, energy intake and individual characteristics

	Bandung			Sumedang		
Physical activity (MET・h)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.10			<0.01
Male	31	3.2		92	5.1	
Female	35	2.9		94	4.0	
Education (adults only)			0.06			0.43
Higher	33	2.7		24	3.6	
Junior high school	8	3.8		25	4.4	
Primary or lower	10	2.7		100	4.2	
Occupation			0.10			<0.01
Housewife	19	2.9		39	4.8	
Non-sedentary	23	2.6		73	4.5	
Sedentary	5	2.4		29	3.6	
Student	16	3.8		28	6.1	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	-0.24		0.05	-0.44		<0.01
Per capita income	-0.20		0.10	0.09		0.25
Energy intake (EI/BMR)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.22			0.13
Male	31	1.4		92	1.3	
Female	35	1.3		94	1.2	
Education (adults only)			0.08			0.06
Higher	33	1.3		24	1.1	
Junior high school	8	1.2		25	1.3	
Primary or lower	10	1.6		100	1.3	
Occupation			0.38			0.05
Housewife	19	1.2		39	1.2	
Non-sedentary	23	1.3		73	1.3	
Sedentary	5	1.3		29	1.2	
Student	16	1.5		28	1.2	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	-0.12		0.32	0.01		0.91
Per capita income	-0.21		0.10	0.04		0.56

[a]the Kruskal-Wallis equality-of-populations rank test. MET: metabolic equivalent. EI: energy intake (kcal). BMR: basal metabolic rate (kcal).

Table 2-G. Association between protein, carbohydrate and fat intake (%EI), and individual characteristics

	Bandung			Sumedang		
Protein intake (%EI)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.75			0.64
Male	31	11.9		92	9.2	
Female	35	12.0		94	9.5	
Education (adults only)			0.10			0.01
Higher	33	11.4		24	10.6	
Junior high school	8	12.1		25	9.3	
Primary or lower	10	12.4		100	8.9	
Occupation			0.95			<0.01
Housewife	19	11.7		39	9.9	
Non-sedentary	23	12.3		73	8.9	
Sedentary	5	11.7		29	10.1	
Student	16	12.2		28	11.0	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	-0.09		0.49	-0.31		<0.01
Per capita income	-0.23		0.06	0.36		<0.01
Carbohydrate intake (%EI)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.39			0.68
Male	31	59.4		92	69.6	
Female	35	60.4		94	69.2	
Education (adults only)			0.73			<0.01
Higher	33	60.5		24	66.5	
Junior high school	8	58.7		25	67.4	
Primary or lower	10	59.2		100	71.4	
Occupation			0.32			<0.01
Housewife	19	60.1		39	69.5	
Non-sedentary	23	59.4		73	70.7	
Sedentary	5	65.4		29	67.5	
Student	16	60.4		28	60.4	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	0.11		0.39	0.48		<0.01
Per capita income	0.23		0.06	-0.33		<0.01

Table 2-G. Association between protein, carbohydrate and fat intake (%EI), and individual characteristics (continued)

	Bandung			Sumedang		
Fat intake (%EI)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.44			0.55
Male	31	27.9		92	19.1	
Female	35	26.9		94	19.4	
Education (adults only)			0.74			<0.01
Higher	33	26.0		24	21.4	
Junior high school	8	27.1		25	21.0	
Primary or lower	10	29.6		100	16.7	
Occupation			0.35			<0.01
Housewife	19	27.9		39	18.7	
Non-sedentary	23	27.9		73	18.0	
Sedentary	5	21.7		29	19.6	
Student	16	26.4		28	27.2	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	-0.09		0.46	-0.49		<0.01
Per capita income	-0.20		0.10	0.29		<0.01

[a]the Kruskal-Wallis equality-of-populations rank test. EI: energy intake (kcal).

Table 2-H. Association between grain/tubers, vegetable/legume and meat/fish intake (%EI), and individual characteristics

	Bandung			Sumedang		
Grain/tubers intake (%EI)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.21			0.69
Male	31	58.6		92	65.8	
Female	35	60.3		94	68.9	
Education (adults only)			0.87			<0.01
Higher	33	59.4		24	60.0	
Junior high school	8	63.7		25	63.2	
Primary or lower	10	59.6		100	70.8	
Occupation			0.53			0.01
Housewife	19	60.3		39	69.3	
Non-sedentary	23	60.3		73	69.0	
Sedentary	5	59.5		29	60.6	
Student	16	54.9		28	61.9	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	0.06		0.61	0.36		<0.01
Per capita income	0.03		0.81	-0.25		<0.01
Vegetables/legumes intake (%EI)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.64			0.84
Male	31	14.4		92	6.5	
Female	35	12.3		94	6.4	
Education (adults only)			0.59			0.16
Higher	33	14.7		24	8.7	
Junior high school	8	17.3		25	6.5	
Primary or lower	10	12.5		100	6.0	
Occupation			0.05			0.03
Housewife	19	17.6		39	8.5	
Non-sedentary	23	13.1		73	5.4	
Sedentary	5	17.3		29	10.9	
Student	16	6.1		28	6.3	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	0.35		<0.01	-0.14		0.06
Per capita income	0.26		0.04	0.17		0.02

Table 2-H. Association between grain/tubers, vegetable/legume and meat/fish intake (%EI), and individual characteristics (continued)

	Bandung			Sumedang		
Meat/fish intake (%EI)						
Categorical variables	n	median	p-value[a]	n	median	p-value[a]
Sex			0.67			0.10
Male	31	8.1		92	4.4	
Female	35	7.2		94	5.9	
Education (adults only)			0.50			<0.01
Higher	33	7.1		24	9.3	
Junior high school	8	8.0		25	5.6	
Primary or lower	10	10.4		100	4.2	
Occupation			0.59			0.25
Housewife	19	7.2		39	7.0	
Non-sedentary	23	7.3		73	4.3	
Sedentary	5	8.1		29	4.6	
Student	16	7.8		28	9.2	
Continuous variables	Spearman's rho		p-value	Spearman's rho		p-value
Age	-0.16		0.19	-0.13		0.07
Per capita income	-0.27		0.03	0.24		<0.01

[a]the Kruskal-Wallis equality-of-populations rank test. EI: energy intake (kcal).

Table 2-I. Intracorrelation coefficients of physical activity level and nutritional/dietary pattern indicators at the household level

	All	By area		By household category			
		Bandung	Sumedang	Double burden	Normal	Overnutrition	Undernutrition
Number of households	94	19	75	24	21	30	19
Number of individuals	252	66	186	85	39	82	46
Physical activity							
MET・h	0.22	0.18	0.17	0.19	0.32	0.36	0.00
Nutritional patterns							
EI/BMR	0.40	0.23	0.45	0.32	0.67	0.28	0.40
Protein intake (%EI)	0.39	0.18	0.33	0.34	0.00	0.43	0.48
Carbo intake (%EI)	0.47	0.36	0.34	0.52	0.45	0.38	0.20
Fat intake (%EI)	0.50	0.42	0.41	0.59	0.61	0.37	0.15
Dietary patterns							
Grain/tubers (%EI)	0.35	0.40	0.24	0.48	0.35	0.05	0.24
Vegetables/legumes (%EI)	0.34	0.20	0.39	0.37	0.64	0.21	0.51
Meat/fish (%EI)	0.08	0.32	0.05	0.28	0.00	0.00	0.57

The mean number of household members of "Normal" category went below 2 due to missing values. BMR: basal metabolic rate. EI: energy intake. MET: metabolic equivalent.

Table 2-J. A comparison of characteristics by household nutritional category

	Double burden n=37	Normal n=29	Overnutrition n=50	Undernutrition n=29	P-value
Number of HH members (mean)	4.6	2.4	3.4	3.0	<0.01[a]
(SD)	(1.9)	(1.3)	(1.4)	(0.9)	
Per capita monthly income (1,000 IDR; mean)	1036.0	599.7	720.0	1157.1	0.05[a]
(SD)	(1671.1)	(956.7)	(561.4)	(3637.1)	
Area					<0.01[b]
Bandung (n)	24	8	26	8	
(%)	(36.4)	(12.1)	(39.4)	(12.1)	
Sumedang (n)	13	21	24	21	
(%)	(16.5)	(26.6)	(30.4)	(26.6)	
HH heads' education[c]					0.02[b]
Primary or lower (n)	13	20	23	18	
(%)	(17.6)	(27.0)	(31.1)	(24.3)	
Junior high school (n)	7	0	10	6	
(%)	(30.4)	(0.0)	(43.5)	(26.1)	
Highschool or higher (n)	17	8	17	5	
(%)	(36.2)	(17.0)	(36.2)	(10.6)	
HH heads' sex					0.25[b]
Male (n)	30	19	40	25	
(%)	(26.3)	(16.7)	(35.1)	(21.9)	
Female (n)	7	10	10	4	
(%)	(22.6)	(32.3)	(32.3)	(12.9)	

HH: household. IDR: Indonesia rupiah. [a]the Kruskal-Wallis equality-of-populations rank test. [b]Pearson's chi-square test. [c]Excluding "unknown" in normal household category.

Table 2-K. Logistic regression analysis of factors associated with being a member of a double burden household

	Coefficient	Standard Error	p-value
Undernourished individuals (n=36)			
Adult	-3.6	1.9	0.05
Sex (female)	0.7	1.1	0.52
Physical activity			
MET・h	-0.4	0.3	0.15
Nutritional/dietary patterns			
EI/BMR	-1.8	1.5	0.22
Protein intake (%EI)	0.7	0.5	0.17
Carbo intake (%EI)	0.5	0.3	0.13
Fat intake (%EI)	0.5	0.3	0.11
Grain/tubers (%EI)	0.1	0.1	0.27
Vegetables/legumes (%EI)	0.0	0.1	0.85
Meat/fish (%EI)	0.0	0.1	0.65
Constant	-49.1	32.2	0.13
Overnourished individuals (n=74)			
Adult	2.5	1.3	0.05
Sex (female)	0.2	0.7	0.77
Physical activity			
MET・h	-0.4	0.2	0.03
Nutritional/dietary patterns			
EI/BMR	1.0	1.1	0.34
Protein intake (%EI)	-0.2	0.2	0.47
Carbo intake (%EI)	-0.6	0.3	0.02
Fat intake (%EI)	-0.6	0.3	0.02
Grain/tubers (%EI)	-0.1	0.0	0.03
Vegetables/legumes (%EI)	-0.1	0.1	0.07
Meat/fish (%EI)	0.0	0.1	0.66
Constant	59.5	25.3	0.02

MET: metabolic equivalent. EI: energy intake. BMR: basal metrabolic rate.

Figures

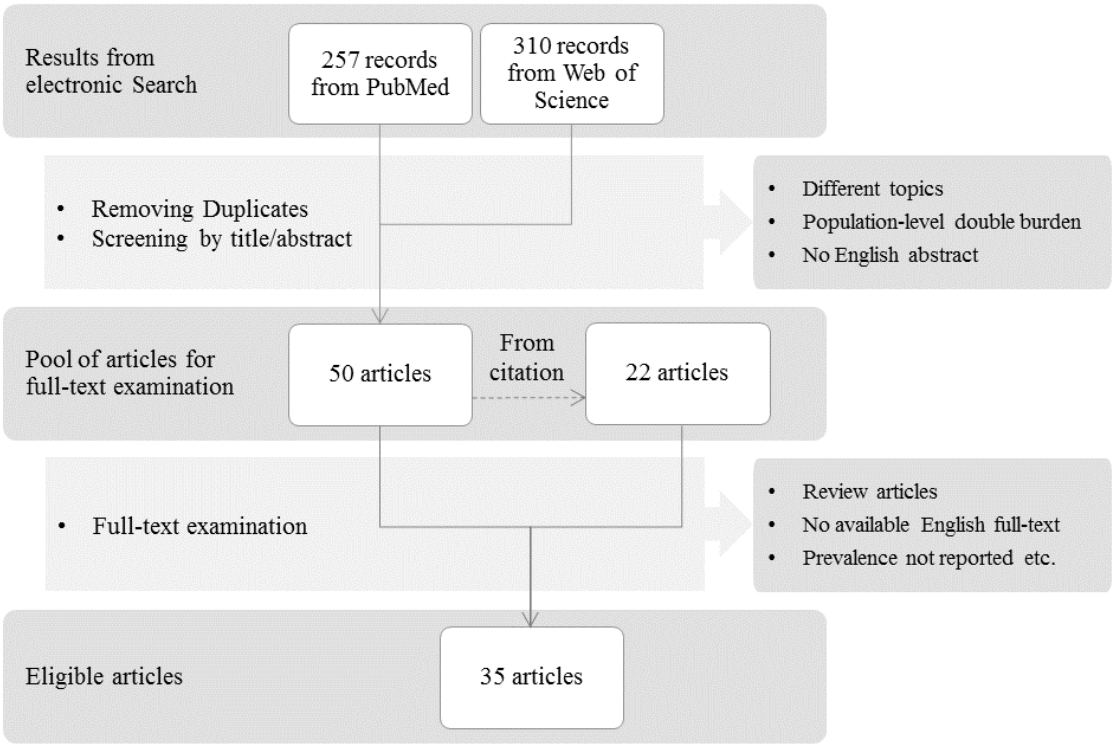

Figure 1-A. Selection process and the number of articles included in the review

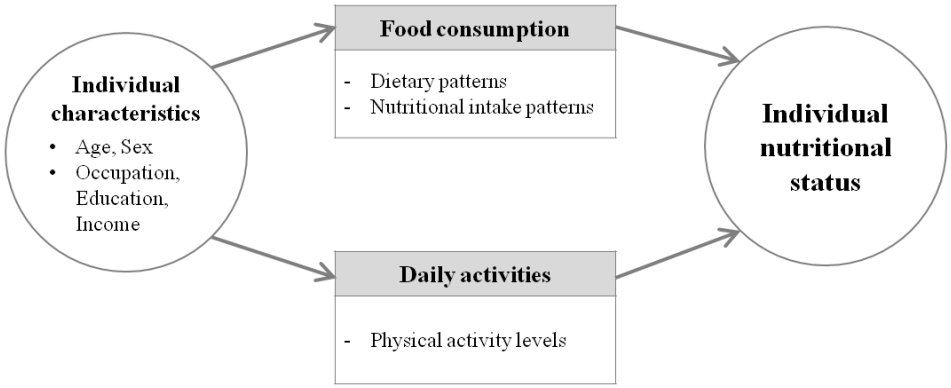

Figure 2-A. Pathways between individual characteristics and nutritional status

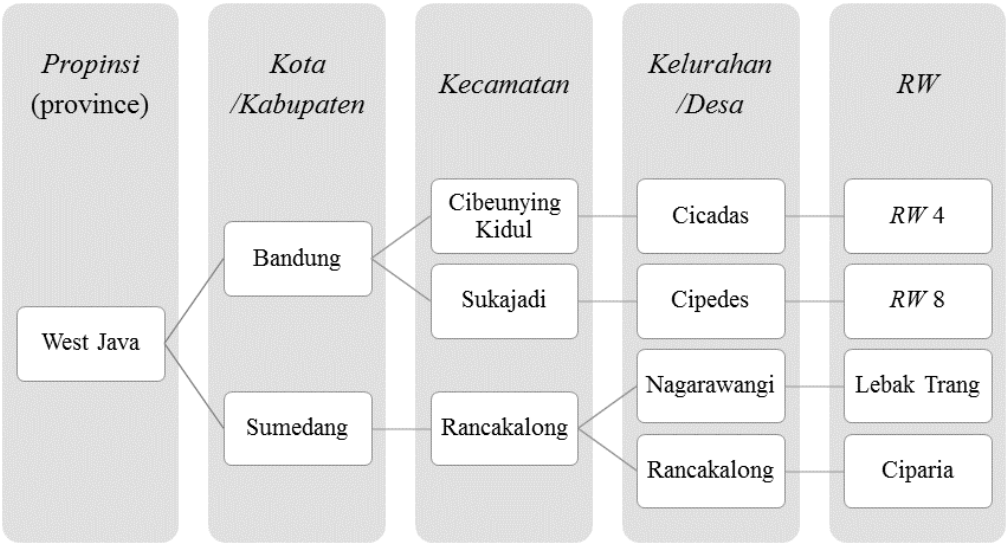

Figure 2-B. Levels of the administrative units from the province of West Java down to the surveyed areas

Appendix

倫　理　委　員　会
審 査 結 果 通 知 書

2014年06月12日

申請者（研究責任者）
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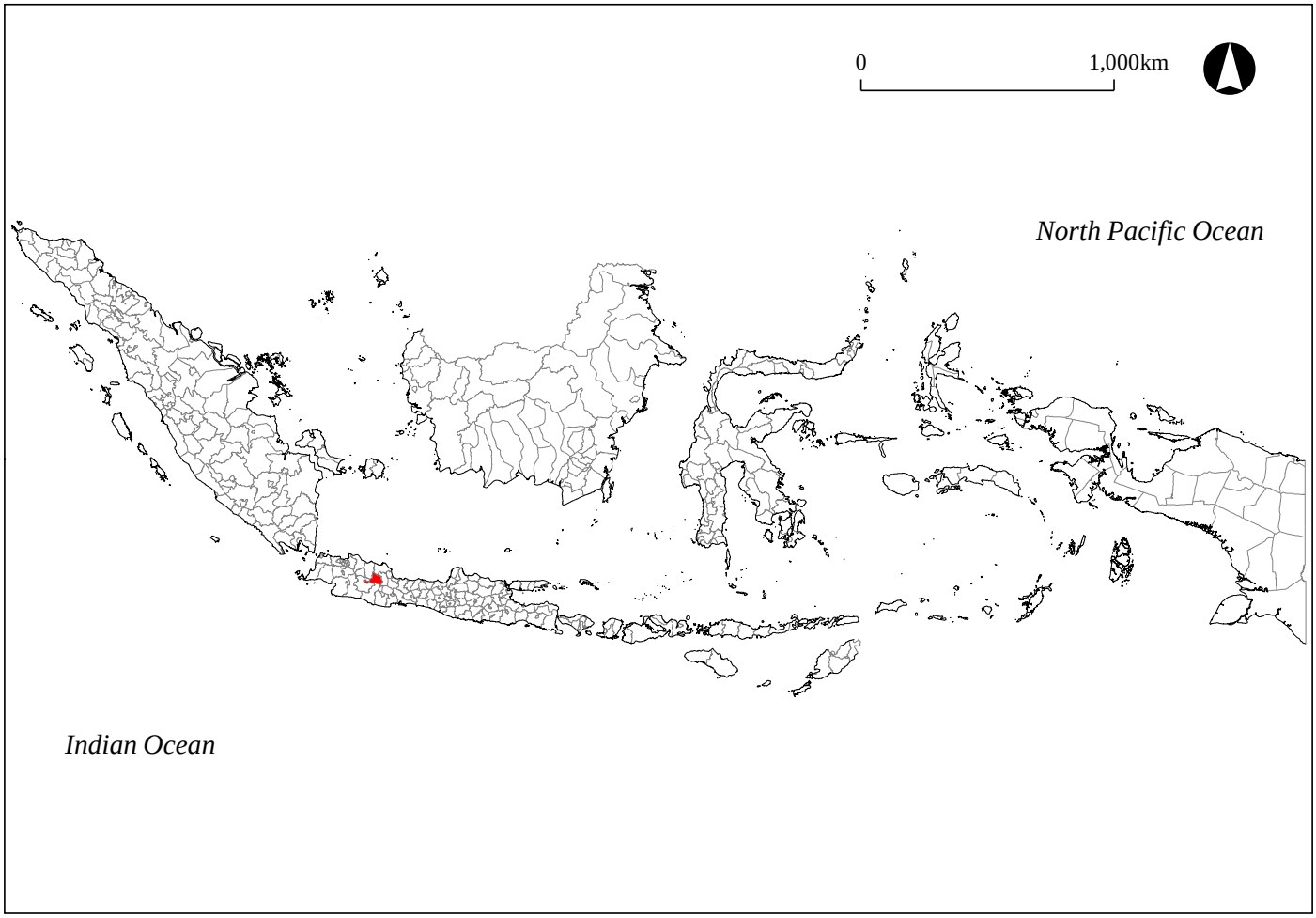
審査番号　10485

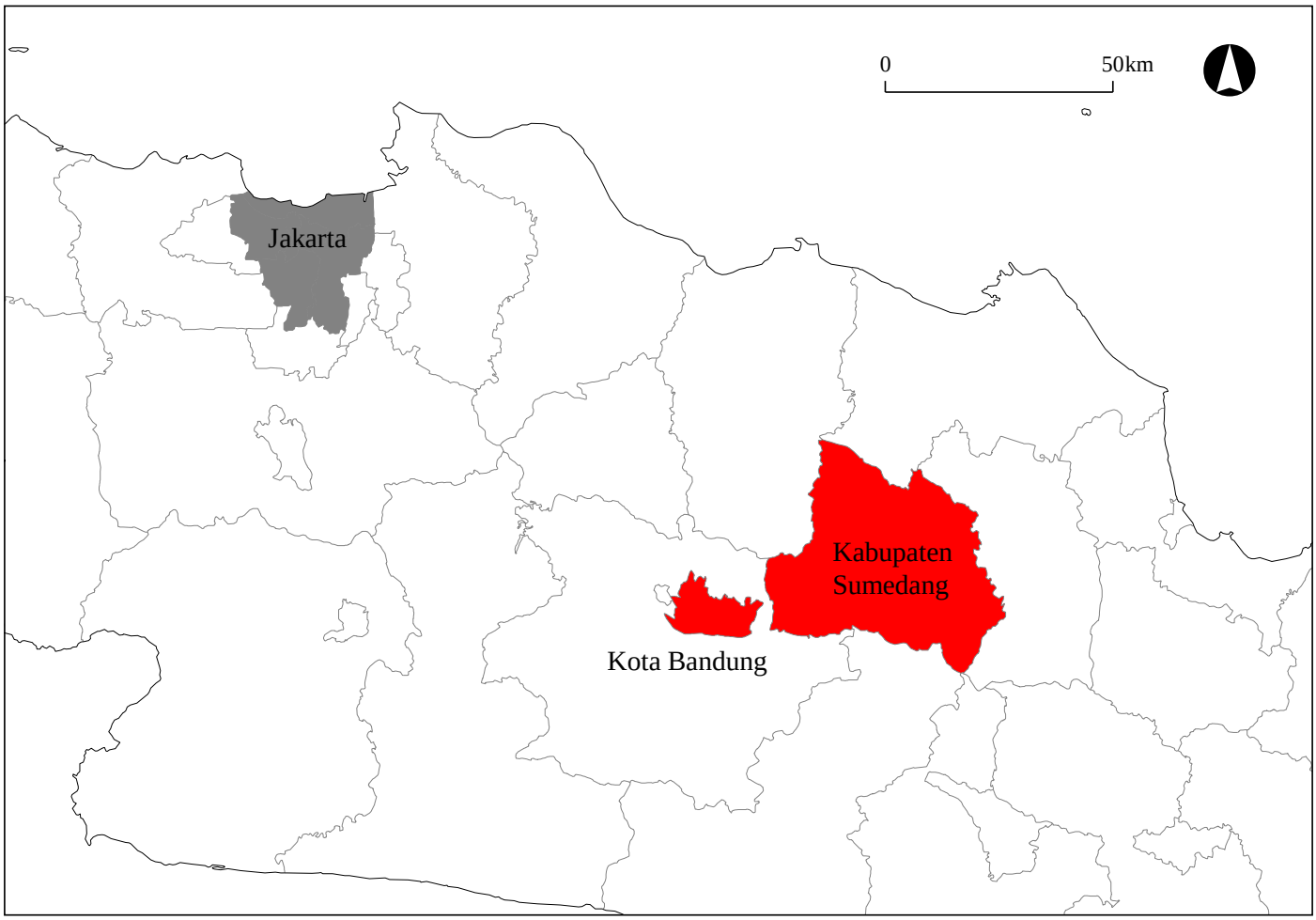
研究課題　インドネシア・バンドン市における栄養不良の二重負荷に関する研究

上記研究計画を2014年06月09日の委員会で審査し下記のとおり判定しました。
ここに通知します。

判　定

○承認する　　条件付きで承認する
変更を勧告する　　承認しない
該当しない





Appendix 2. Map of Indonesia and locations of the survey field

HHID: _____ Alamat: _____

Berapa rupiah total jumlah penghasilan tambahan (sewa kamar, ganti rugi asuransi, etc) dalam 12 bulan terakhir?

_____. _____. _____. _____ Rp.

PID	name	sex	birthdate	age	marital	education
Nomor Urut ART	Nama Anggota Rumah Tangga (ART)	Jenis Kelamin	TGL/BULAN/TAHUN LAHIR	Berapa umur sekarang?	Status Perkawinan	Pendidikan tertinggi yang pernah diikuti ART
1		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
2		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
3		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
4		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
5		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
6		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
7		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
8		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
9		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	
10		1. Laki-laki 3. Perempuan	____ / ____ / _____	_____	1. 2. 3. 4. 5. 8.	

Status Perkawinan

1. Belum kawin
2. Kawin
3. Pisah
4. Cerai hidup
5. Cerai mati
8. TIDAK TAHU

Pendidikan tertinggi

01. Tidak/belum sekolah
02. SD
03. SMP (SLP/SLTP)
05. SMU (SMA/SLA/SLTA/SMK)
60. Akademi
61. Universitas
90. Taman Kanak-Kanak
95. TIDAK TAHU
98. Lainnya

HHID: _____

PID	activity	jcategory	jsector	income	bp1/bp2	weight	height
Nomor Urut ART	Apa kegiatan terbanyak yang Ibu/Bapak/Sdr lakukan selama seminggu yang lalu?	Apa status pekerjaan Ibu/Bapak/Sdr tersebut?	Apa lapangan usaha Ibu/Bapak/Sdr tersebut?	Berapa kira-kira keuntungan bersih yang diperoleh pada pekerjaan ART selama sebulan yang lalu?	Tekanan darah (ART umur ≥ 15 tahun)	Berat badan (kg)	Tinggi Badan (cm)
1				_____._____._____Rp	_____ / _____	_____. __	_____. __
2				_____._____._____Rp	_____ / _____	_____. __	_____. __
3				_____._____._____Rp	_____ / _____	_____. __	_____. __
4				_____._____._____Rp	_____ / _____	_____. __	_____. __
5				_____._____._____Rp	_____ / _____	_____. __	_____. __
6				_____._____._____Rp	_____ / _____	_____. __	_____. __
7				_____._____._____Rp	_____ / _____	_____. __	_____. __
8				_____._____._____Rp	_____ / _____	_____. __	_____. __
9				_____._____._____Rp	_____ / _____	_____. __	_____. __
10				_____._____._____Rp	_____ / _____	_____. __	_____. __

Kegiatan

01. Bekerja/berusaha untuk memperoleh/membantu memperoleh penghasilan
02. Mencari pekerjaan
03. Bersekolah
04. Mengurus rumah tangga
05. Pensiun/ sudah tua
07. Sakit/cacat
09. berlibur/ baru saja lulus
95. Lainnya

Status

01. Usaha sendiri
04. karyawan pemerintah
05. Buruh/ karyawan swasta
08. Pekerja lepasan

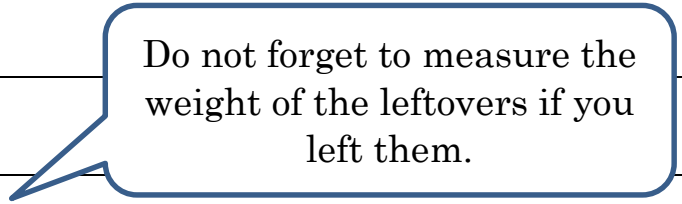
Lapangan usaha

01. Pertanian, Kehutanan, Perikanan dan Perburuan
02. Pertambangan dan Penggalian
03. Manufaktur/ Industri Pengolahan
04. Listrik, Gas dan Air
05. Bangunan
06. Perdagangan Besar, Eceran, Rumah Makan dan Hotel
07. Angkutan, Pergudangan dan Komunikas
08. Keuangan, Asuransi, Usaha Persewaan, Bangunan, Tanah dan Jasa Perusahaan
09. Jasa Kemasyarakatan
10. Aktivitas lainnya yang tidak dapat dikelompokkan

Name of Household Head: EXAMPLE

Name: EXAMPLE Date: 25 / 9 / 2014 (weekday ・ holiday)

	TIME	PLACE	NAME OF ITEM	AMOUNT	MEMO (brand, ingredients, etc.)
1	8:30 AM	HOME	PLATE	258 g	
2			+ NASI PUTIH	443 g	
3			+ TEMPE GORENG	488 g	2 slices
4			+ VEGETABLE SOUP	618 g	
5			+ SAMBAL	627 g	
6			- LEFTOVERS	378 g	
7			COFFEE	150 g	1 sachet of “ABC KOPI SUSU” used
8					
9	12:30 PM	WORK PLACE	MIE BASO	1 BOWL	noodle, vegetables, meatballs
10			+ SAMBAL	1 SPOON	
11			- LEFTOVERS		half of soup



Nama KK : Tn. X

Nama : A

Tanggal : 17 / 8 / 2015 (hari kerja • hari libur)

	JAM	TEMPAT	NAMA MAKANAN/BARANG	JUMLAH	KETERANGAN (MERK, BUMBU, SISA MAKANAN)
1	8:30	RUMAH	PIRING	258 g	
2			+ NASI PUTIH	443 g	
3			+ TEMPE GORENG	488 g	2 POTONG
4			+ SOP	618 g	
5			+ SAMBAL	627 g	
6			- SISA MAKANAN	378 g	
7			GELAS	150 g	
8			+ KOPI	293 g	1 sachet “ABC KOPI SUSU”
9	13:30	RUMAH	MANGKOK	332 g	
10			+ MIE BASO	639 g	MIE, BASO, SAYUR
11			+ SAMBAL	654 g	

Jangan lupa untuk mengukur berat makanan yang tersisa (berat piring + sisa makanan)

Nama KK : _____

Nama : _____ Tanggal : __ / __ / 2015 [hari kerja (Senin-Jumat) • hari libur (Sabtu-Minggu)]

NO.	JAM	TEMPAT	NAMA MAKANAN/BARANG	JUMLAH	KETERANGAN (MERK, BUMBU, SISA MAKANAN)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

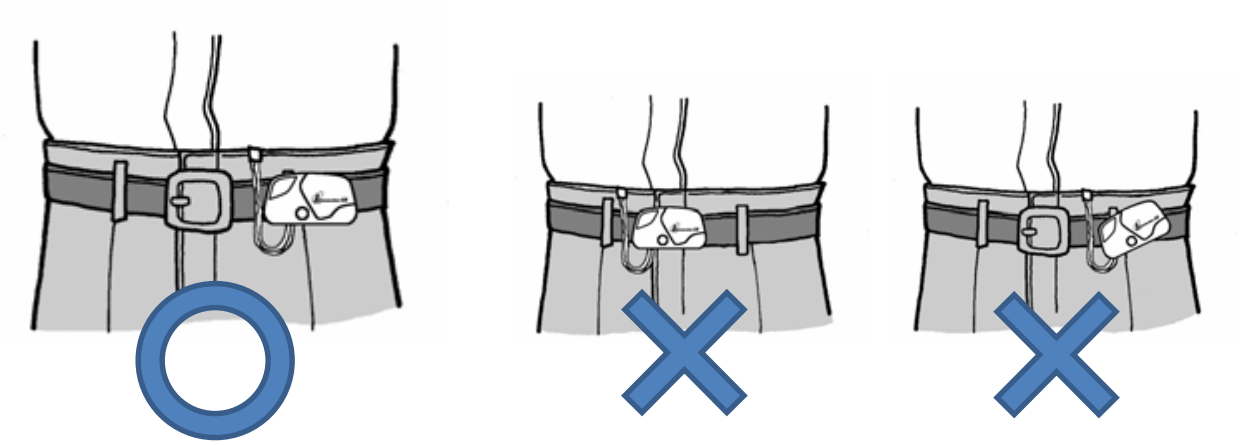
NO.	JAM	TEMPAT	NAMA MAKANAN/BARANG	JUMLAH	KETERANGAN (MERK, BUMBU, SISA MAKANAN)
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					

Cara Menggunakan Alat Pengukur Aktivitas Fisik

Accelerometer (alat pengukur aktivitas fisik) akan digunakan untuk menghitung jumlah langkah yang dilakukan dan juga jumlah aktivitas fisik yang dikerjakan setiap 2 menit.

Cara penggunaan

1. Setelah bangun tidur, segera pasang alat pengukur aktivitas fisik di pinggang (digantungkan pada celana, rok, atau ikat pinggang). Mohon dipasang sesuai dengan gambar.



2. Alat pengukur aktivitas fisik harus dipasang setiap saat kecuali saat tidur, mandi, atau berenang.

Jangka waktu penggunaan: ___ / ___ s/d ___ / ___

No._____ Nama _____
No._____ Nama _____
No._____ Nama _____
No._____ Nama _____
No._____ Nama _____
No._____ Nama _____

Appendix 7. Results of a regression analysis for body mass index with age, age-squared, physical activity level and nutritional intake pattern indicators by area

	Bandung		Sumedang	
	Coefficient	p-value	Coefficient	p-value
Age (year)	0.426	<0.01	0.448	<0.01
Age-squared (year^2)	-0.003	0.03	-0.005	<0.01
Sex (female)	1.950	0.05	1.919	<0.01
Physical activity				
MET·h	-0.087	0.75	-0.006	0.96
Nutritional intake patterns				
EI/BMR	-2.855	0.05	-2.694	<0.01
Protein intake (%EI)	3.901	0.86	0.733	0.96
Fat intake (%EI)	12.323	0.08	7.006	0.15
Constant	13.141	<0.01	14.991	<0.01
R^2	0.553		0.329	
adujusted R^2	0.499		0.302	

MET: metabolic equivalent. EI: energy intake (kcal). BMR: basal metabolic rate (kcal).

Appendix 8. Intracorrelation coefficients of physical activity level and nutritional/dietary pattern indicators at the household level

	UN child(ren) and ON adult(s)	UN child(ren) and ON mother
Number of households	23	19
Number of individuals	83	69
Physical activity		
MET·h	0.20	0.16
Nutritional patterns		
EI/BMR	0.33	0.34
Protein intake (%EI)	0.35	0.33
Carbo intake (%EI)	0.55	0.59
Fat intake (%EI)	0.61	0.64
Dietary patterns		
Grain/tubers (%EI)	0.48	0.55
Vegetables/legumes (%EI)	0.37	0.42
Meat/fish (%EI)	0.29	0.26

BMR: basal metabolic rate. EI: energy intake. MET: metabolic equivalent. ON: overnourished. UN: undernourished.

Appendix 9. A comparison of characteristics by household nutritional category limitting double burden households to those with undernourished child(ren) and overnourished adult(s)

	Double burden n=32	Normal n=29	Overnutrition n=50	Undernutrition n=29	P-value
Number of HH members (mean)	4.7	2.4	3.4	3.0	<0.01[a]
(SD)	(2.0)	(1.3)	(1.4)	(0.9)	
Per capita monthly income (1,000 IDR; mean)	986.5	599.7	720.0	1157.1	0.07[a]
(SD)	(1731.5)	(956.7)	(561.4)	(3637.1)	
Area					<0.01[b]
Bandung (n)	20	8	26	8	
(%)	(32.3)	(12.9)	(41.9)	(12.9)	
Sumedang (n)	12	21	24	21	
(%)	(15.4)	(26.9)	(30.8)	(26.9)	
HH heads' education[c]					0.04[b]
Primary or lower (n)	12	20	23	18	
(%)	(16.4)	(27.4)	(31.5)	(24.5)	
Junior high school (n)	6	0	10	6	
(%)	(27.3)	(0.0)	(45.5)	(27.3)	
Highschool or higher (n)	14	8	17	5	
(%)	(31.8)	(18.2)	(38.6)	(11.4)	
HH heads' sex					0.25[b]
Male (n)	26	19	40	25	
(%)	(23.6)	(17.3)	(36.4)	(22.7)	
Female (n)	6	10	10	4	
(%)	(20.0)	(33.3)	(33.3)	(13.3)	

HH: household. IDR: Indonesia rupiah. [a]the Kruskal-Wallis equality-of-populations rank test. [b]Pearson's chi-square test. [c]Excluding "unknown" in normal household category.

Appendix-10. A comparison of characteristics by household nutritional category limitting double burden households to those with undernourished child(ren) and overnourished mother

	Double burden n=28	Normal n=29	Overnutrition n=50	Undernutrition n=29	P-value
Number of HH members (mean)	4.6	2.4	3.4	3.0	<0.01[a]
(SD)	(2.2)	(1.3)	(1.4)	(0.9)	
Per capita monthly income (1,000 IDR; mean)	1196.4	599.7	720.0	1157.1	0.04[a]
(SD)	(1891.9)	(956.7)	(561.4)	(3637.1)	
Area					0.01[b]
Bandung (n)	17	8	26	8	
(%)	(28.8)	(13.6)	(44.1)	(13.6)	
Sumedang (n)	11	21	24	21	
(%)	(14.3)	(27.3)	(31.2)	(27.3)	
HH heads' education[c]					0.04[b]
Primary or lower (n)	10	20	23	18	
(%)	(14.1)	(28.2)	(32.4)	(25.4)	
Junior high school (n)	6	0	10	6	
(%)	(27.3)	(0.0)	(45.5)	(27.3)	
Highschool or higher (n)	12	8	17	5	
(%)	(28.6)	(19.1)	(40.5)	(11.9)	
HH heads' sex					0.24[b]
Male (n)	23	19	40	25	
(%)	(21.5)	(17.8)	(37.4)	(23.4)	
Female (n)	5	10	10	4	
(%)	(17.2)	(34.5)	(34.5)	(13.8)	

HH: household. IDR: Indonesia rupiah. [a]the Kruskal-Wallis equality-of-populations rank test. [b]Pearson's chi-square test. [c]Excluding "unknown" in normal household category.

Appendix 11. Logistic regression analysis of factors associated with being a member of a double burden household among overnourished individuals, including "area" variable additionally (n=74)

	Coefficient	Standard Error	p-value
Adult	2.4	1.3	0.07
Sex (Female)	0.3	0.7	0.70
Area (Bandung)	1.1	0.9	0.23
Physical activity			
MET·h	-0.3	0.2	0.10
Nutritional/dietary patterns			
EI/BMR	0.7	1.1	0.55
Protein intake (%EI)	-17.2	25.2	0.49
Carbo intake (%EI)	-54.0	27.8	0.05
Fat intake (%EI)	-53.1	27.2	0.05
Grain/tubers (%EI)	-0.1	0.0	0.03
Vegetables/legumes (%EI)	-0.1	0.1	0.04
Meat/fish (%EI)	0.0	0.1	0.62
Constant	52.8	26.3	

MET: metabolic equivalent. EI: energy intake. BMR: basal metrabolic rate.

Appendix 12. Logistic regression analysis of factors associated with being a member of a double burden household by adult/child category

	Adults		Children	
	Coefficient	p-value	Coefficient	p-value
Overnourished individuals	*(n=66)*		*(n=8)*	
Sex (Female)	0.9	0.28		
Physical activity				
MET·h	-0.6	0.01		
Nutritional/dietary patterns				
EI/BMR	1.0	0.39		
Protein intake (%EI)	-35.9	0.18		
Carbo intake (%EI)	-74.0	0.01		
Fat intake (%EI)	-68.1	0.02		
Grain/tubers (%EI)	0.0	0.19		
Vegetables/legumes (%EI)	-0.1	0.04		
Meat/fish (%EI)	0.1	0.50		
Constant	72.2	0.01		
Undernourished individuals	*(n=12)*		*(n=24)*	
Sex (Female)			1.8	0.34
Physical activity				
MET·h			-0.4	0.28
Nutritional/dietary patterns				
EI/BMR			-2.9	0.18
Protein intake (%EI)			20.6	0.73
Carbo intake (%EI)			10.2	0.85
Fat intake (%EI)			10.8	0.86
Grain/tubers (%EI)			0.1	0.46
Vegetables/legumes (%EI)			-0.2	0.15
Meat/fish (%EI)			0.1	0.26
Constant			-7.3	0.89

MET: metabolic equivalent. EI: energy intake.
BMR: basal metrabolic rate.

Appendix 13. Logistic regression analysis of factors associated with being a member of a household with undernourished child(ren) and overnourished adult(s)

	Coefficient	Standard Error	p-value
Undernourished individuals (n=36)			
Adult	-4.0	1.9	0.04
Sex (female)	1.5	1.2	0.22
Physical activity			
MET・h	-0.4	0.3	0.22
Nutritional/dietary patterns			
EI/BMR	-1.9	1.5	0.21
Protein intake (%EI)	0.4	0.5	0.41
Carbo intake (%EI)	0.2	0.3	0.59
Fat intake (%EI)	0.2	0.3	0.47
Grain/tubers (%EI)	0.1	0.1	0.21
Vegetables/legumes (%EI)	-0.1	0.1	0.54
Meat/fish (%EI)	0.0	0.1	0.68
Constant	-20.3	32.6	0.53
Overnourished individuals (n=74)			
Adult	2.0	1.2	0.11
Sex (female)	-0.1	0.7	0.92
Physical activity			
MET・h	-0.5	0.2	0.01
Nutritional/dietary patterns			
EI/BMR	1.1	1.0	0.28
Protein intake (%EI)	-0.2	0.2	0.51
Carbo intake (%EI)	-0.6	0.3	0.03
Fat intake (%EI)	-0.6	0.3	0.03
Grain/tubers (%EI)	-0.1	0.0	0.05
Vegetables/legumes (%EI)	-0.1	0.0	0.10
Meat/fish (%EI)	0.0	0.1	0.65
Constant	54.4	24.7	0.03

MET: metabolic equivalent. EI: energy intake. BMR: basal metrabolic rate.

Appendix 14. Logistic regression analysis of factors associated with being a member of a household with undernourished child(ren) and overnourished mother

	Coefficient	Standard Error	p-value
Undernourished individuals (n=36)			
Adult	-3.3	1.5	0.03
Sex (female)	0.7	1.3	0.60
Physical activity			
MET・h	-0.2	0.2	0.44
Nutritional/dietary patterns			
EI/BMR	-1.8	1.6	0.25
Protein intake (%EI)	0.2	0.4	0.64
Carbo intake (%EI)	-0.1	0.3	0.69
Fat intake (%EI)	-0.3	0.4	0.50
Grain/tubers (%EI)	0.0	0.1	0.85
Vegetables/legumes (%EI)	-0.1	0.1	0.38
Meat/fish (%EI)	0.1	0.1	0.40
Constant	17.3	33.4	0.61
Overnourished individuals (n=74)			
Adult	1.7	1.2	0.16
Sex (female)	0.4	0.7	0.59
Physical activity			
MET・h	-0.3	0.2	0.10
Nutritional/dietary patterns			
EI/BMR	1.1	1.0	0.26
Protein intake (%EI)	-0.1	0.2	0.74
Carbo intake (%EI)	-0.5	0.3	0.05
Fat intake (%EI)	-0.5	0.3	0.04
Grain/tubers (%EI)	-0.1	0.0	0.02
Vegetables/legumes (%EI)	-0.1	0.0	0.03
Meat/fish (%EI)	0.0	0.1	0.47
Constant	49.7	24.5	0.04

MET: metabolic equivalent. EI: energy intake. BMR: basal metrabolic rate.