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Dual Burden Households and Nutritional Inequality in Indonesia

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Abstract: Overweight is an increasing problem in many developing countries, coexisting with underweight and contributing to a dual burden of malnutrition, sometimes in the same households. We analyze the dual burden phenomenon in Indonesia, using panel data that span a time period of 15 years. Today, 17 percent of the Indonesian households are classified as dual burden. In these households, children are often underweight, whereas adults are overweight. The nutrition transition seems to have differential impacts on the body mass index of different age cohorts. Dual burden is a transitory phenomenon. It started in the richer population segments, but today the highest prevalence is observed in the lowest expenditure quintile. Most households that moved out of the dual burden category end up as overweight. We also develop a continuous Theil index of intra-household nutritional inequality. While the prevalence of dual burden households has hardly changed over the last 10 years, the Theil index increased steadily. The reason is that intra-household inequality is also rising within household categories. Such inequality makes policy design more complex; food and nutrition interventions need to be targeted more specifically at subgroups within households. Further socioeconomic determinants are analyzed econometrically. Female decision-making reduces intra-household nutritional inequality.

Keywords: Dual burden, Intra-household inequality, Nutrition transition, Asia, Indonesia

JEL: I10, O12

1 Introduction

Many developing countries face increasing rates of overweight and obesity. In Latin America and North Africa, this problem has been recognized for a while; in many countries of Asia and Sub-Saharan Africa it has entered the research and policy agenda more recently (Jones-Smith et al., 2011a, b; Martorell et al., 2000; Ziraba et al., 2009). Overweight and obesity are the result of changing food consumption and physical activity patterns caused by rising incomes, urbanization, and globalization. These trends have been termed the nutrition transition (e.g. Popkin, 2003; Popkin and Gordon-Larsen, 2004). Obesity is associated with many chronic diseases, so that policy attention is required. Designing appropriate policy responses is difficult. The task is challenging especially in situations where overnutrition coexists with undernutrition, which is often referred to as the dual burden of malnutrition (Khor, 2008).

This dual burden phenomenon occurs at the country level, but sometimes it is also observed at the household level, implying that there are overweight and underweight individuals living in the same household (e.g. Doak et al., 2005). Obviously, there are factors within households that contribute to nutritional inequality, which is in line with research on intra-household resource allocation (e.g., Alderman et al., 1995; Thomas, 1990). The existing literature on intra-household dual burden tends to categorize households in a discrete way: based on the body mass index (BMI) or similar indicators of nutritional status of individual members, households are classified as underweight, normal, overweight, or dual burden. Doak et al. (2000) and Doak et al. (2005) found dual burden households in Brazil, China, Indonesia, Kyrgyz Republic, Russia, Vietnam, and the United States. One aspect that has received particular attention in the literature is the relationship between dual burden and income. For example, in Indonesia and China, dual burden and overweight households are generally richer than the rest; in other countries like Brazil and Russia, dual burden households tend to have lower than average incomes (Doak et al., 2002; Doak et al., 2005).

Other studies focus more specifically on mother and child pairs, because underweight children and overweight mothers are paradoxically the most common combination observed in dual burden households. Jehn and Brewis (2009) found that these pairs exist mainly in higher income and urban locations. Khor and Sharif (2003) and Saibul et al. (2009) analyzed relationships between dual burden

mother-child pairs, food intake, dietary diversity, and health in Malaysia. There is also research that looks at mother-child pairs but uses stunting instead of underweight as the nutritional indicator for children (e.g., Garret and Ruel, (2005). In their studies in Guatemala, Lee et al. (2010) and Lee at al. (2011) found that the combination of child stunting and maternal overweight is characteristic of the most disadvantaged population groups, especially poor rural and indigenous households.

We analyze the phenomenon of dual burden households in Indonesia, contributing to the international literature with two particular innovations. First, while existing studies have used either single round or repeated cross-section data, we employ household panel data, which allows us to examine nutritional dynamics more explicitly. For instance, knowing whether a dual burden household in one period is still classified as dual burden in subsequent periods can help to better understand possible nutritional shifts. Indonesia is one of the few developing countries, for which suitable panel data are available. Second, in addition to working with the common dual burden household classification, which depends on BMI thresholds, we introduce the Theil index as a continuous measure of intra-household nutritional inequality. We build on work by Sahn and Younger (2009), who developed and used a Theil index for BMI to analyze the relationship between inequality at the country and the household level. To our knowledge, no previous study has used a continuous measure of intra-household inequality to study the dual burden phenomenon. We expect that this may add interesting insights. The main objective of this research is to better understand the trends and determinants of dual burden and intra-household nutritional inequality, which is important to enhance food and nutrition policies in Indonesia and beyond.

2 Data and methods

2.1 Data

This study uses the Indonesian Family and Life Survey (IFLS) of the RAND Corporation, an international public policy research institute headquartered in the USA. IFLS encompasses four survey waves that were carried out in 1993 (IFLS1), 1997 (IFLS2), 2000 (IFLS3), and 2007 (IFLS4). The data are representative for 83 percent of the Indonesian population (13 out of 27 provinces). The

selection of the provinces was done taking account of the high heterogeneity of the population. The following provinces are included: North Sumatra, West Sumatra, South Sumatra, and Lampung (in Sumatra), DKI Jakarta, West Java, Central Java, DI Yogyakarta, and East Java (in Java), as well as Bali, West Nusa Tenggara, South Kalimantan, and South Sulawesi. Villages and households were sampled using the National Socioeconomic Survey (SUSENAS) sampling frame of the Indonesian Bureau of Statistics. Further information about the sampling scheme and survey design is given in Frankenberg and Karoly (1995), Frankenberg and Thomas (2000), Strauss et al. (2004), and Strauss et al. (2009).

In the first wave of the survey in 1993, only selected members of the sampled households were interviewed and measured. From 1997 onward, all household members were included. Thus, in the first wave, results may differ. In particular, the 15 to 25 year age group has a relatively low population share in IFLS1. But when we compare this age group over the years, results seem plausible, and we could not identify any obvious bias. Therefore, data from all four survey waves are included in our analysis.

2.2 Measures of nutrition and nutritional inequality

2.2.1 THE BMI

We use two measures to analyze intra-household dual burden and nutritional inequality, namely a discrete categorization of households and the continuous Theil index. These measures themselves are described below. Both build on the BMI of individual household members. The BMI is calculated by dividing the weight of a person in kilograms by the squared height in meters. It is widely recognized as a relatively accurate measure of nutritional outcomes for adults (WHO, 1995, 2000). For children and adolescents, the BMI is less commonly used, because body composition changes rapidly during growth. However, standardized BMI-for-age measures can be calculated to allow comparison across different age and gender groups (see further details below) (Mei et al., 2002; WHO, 1995). For this purpose, optimal growth curves, which represent international standards for every month of life

until the age of 19 years, are available. These optimal growth curves have been updated recently (de Onis et al., 2007; WHO, 2009).

2.2.2 *DUAL BURDEN HOUSEHOLDS*

To identify dual burden households, we classify households into four categories: underweight, normal weight, overweight, and dual burden (Doak et al., 2002; Doak et al., 2005; Doak et al., 2000; Doak et al., 1999). This classification takes into account the nutritional status of individual household members. For adults, individual level BMI is compared with cut-off values of the BMI for overweight and underweight. Concerning the overweight cut-off, Asian populations were found to have a higher risk of chronic disease already at lower levels of body fat and BMI than other ethnic groups (Deurenberg et al., 2002; Gurrici et al., 1998; WHO, 2004). Hence, instead of using the international BMI cut-off of 25, we use the cut-off for Asian populations of 23 to identify overweight adult individuals. For underweight in adults, we use the international cut-off of 18.5 (WHO, 1995), because clear health risk differences between Asian and other populations have not been reported in the literature.

For children and adolescents, we calculate the BMI-for-age. Together with the above mentioned optimal growth curves that account for age and gender, this is considered a good indicator for overweight and underweight (Cole et al., 2007; Mei et al., 2002). As for other measures of child undernutrition, the optimal growth curves are used to calculate BMI-for-age z-scores, which are then comparable across different groups. The z-scores indicate the distance from the optimum, measured in terms of standard deviations. A z-score of -2 is the cut-off for underweight; a z-score of +1 is the cut-off for overweight (de Onis, 2010; WHO, 2012). There is some debate whether the international growth standards are a good reference base for children in Asia (de Haen et al., 2011). But widely accepted growth standards only for Asian populations are not available.

Based on the nutritional status of individual household members, a normal weight household is defined as a household that consists of only normal weight members. An underweight household has at least one underweight member and a variable number of normal weight members. An overweight

household has at least one overweight member in addition to other overweight or normal weight members. A dual burden household has at least one underweight and one overweight member.

2.2.3 INTRA-HOUSEHOLD NUTRITIONAL THEIL INDEX

Our second measure of intra-household nutritional inequality is the Theil index of BMI. The Theil index is a continuous measure and thus helps to reduce possible problems associated with constant cut-offs and high levels of heterogeneity within household categories. Building on the method proposed by Sahn and Younger (2009), we standardize the BMI z-score (z) for all individuals to the BMI reference standard of a fixed age-sex reference group. The following formula is used and solved for BMI:

(1) $$z = \frac{((BMI/m)^{l}-1)}{(l*s)},$$

(2) $$BMI = m(z * l * s + 1)^{\frac{1}{l}}$$

where m, l, and s are the median, the Box-Cox transformation parameter, and the coefficient of variation of the fixed age-sex reference group (WHO, 2009). Once all z-scores have been converted into standardized BMIs, we calculate the household-level Theil index (T_H) as follows:

(3) $$T_H = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{BMI_i}{\overline{BMI}} * \ln\left(\frac{BMI_i}{\overline{BMI}}\right)\right)$$

where BMI_i is the standardized BMI of the individual, $\overline{BMI}$ is the mean standardized BMI of the household, and N is the number of household members.

As Sahn and Younger (2009) did, we chose a 20-year old female as the fixed age-sex reference group for the calculation of standardized BMIs. This is an arbitrary selection, which affects the absolute values of the standardized BMIs and also the Theil index. Yet, as we use the same reference for all individuals and all survey rounds, comparisons across households and time are unaffected by this choice. Higher values of the index indicate higher levels of intra-household nutritional inequality and vice versa.

2.3 Statistical analysis

The first part of our analysis focuses on the descriptive investigation of the dual burden phenomenon and of intra-household nutritional inequality, including trends over time. Moreover, the association with different socioeconomic factors is analyzed descriptively. The second part of the analysis builds on regression models, in order to examine possible determinants of intra-household nutritional inequality more formally.

2.3.1 REGRESSION MODELS

We develop and estimate two different types of models, one where we use dummies for the household categories as dependent variables, and the other where the Theil index is regressed on a set of covariates. To explain household categories, we use probit specifications, comparing dual burden households with other categories. In a first probit model, we compare dual burden with all other households combined. In a second model, we compare dual burden only with normal weight and underweight households, whereas in a third model we compare dual burden with overweight households. We use a random effects probit estimator with all four waves of the panel. A fixed effects estimator would have been interesting to control for possible unobserved household heterogeneity. However, the fixed effects probit estimator requires variation in the outcome variable within households. Hence, households that remain in the same category over time would be dropped, which would have reduced the sample size considerably. As an alternative to separate probit models, a multinomial panel model for the different household categories was tried but did not converge.

To explain the intra-household Theil index, which is a continuous measure, we estimate both random and fixed effects models. The fixed effects estimator is always consistent, because it does not rely on the assumption of no correlation between the covariates and the error term. However, time-invariant covariates automatically drop out in fixed effects estimation, and the effects of almost time-invariant covariates cannot be estimated efficiently. This is a drawback, because many household variables of interest, such as education or occupation of the household head, do not change substantially over time. For the analysis of such factors, the random effects estimator is better,

although endogeneity may potentially be an issue. Time dummies are included in all regressions to account for time fixed effects.

2.3.2 COVARIATES

Several factors can be thought of as likely determinants of intra-household nutritional inequality, such as the distribution of food, physical activity, and healthcare. Since data on intra-household distribution are not available, we use more general characteristics such as household living standard, location, composition, and characteristics of the household head as covariates in the regression models.

Living standard is measured in terms of monthly per capita expenditures for food and all other consumer goods and services. For household location, we differentiate between rural and urban and also include province dummies. Household composition is considered in terms of the number and mean age of household members, the number of children and adolescents under the age of 19, and the number of working household members. Characteristics of the household head are important for consumption and distribution decisions. We look in particular at gender, age, and education levels of the household head. Education levels are defined as dummies for “no education”, “primary school”, “secondary school”, and “tertiary education”. Moreover, we have data on the occupation of the household head, which can influence time allocation, physical activity, and occupational choices of other household members. The occupation of the household head is categorized by occupation dummies for sedentary work, light work, medium work, heavy work, housekeeping, unemployed, and retired. Summary statistics for all covariates used in the regressions are shown in Table A1 in the Appendix.

3 Results

3.1 Prevalence rates and time trends

Table 1 shows that 17 percent of all households were classified as dual burden households in 2007. This proportion is bigger than it was in 1993, but is has been relatively stable since 1997. In comparison, the proportion of underweight households has declined steadily between 1993 and 2007. Especially after 2000, the proportion of underweight households has dropped considerably, reaching 15 percent in 2007. The proportion of normal weight households has also declined, while the proportion of overweight households has increased rapidly. In 2007, 51 percent of all households were categorized as overweight, compared to 35 percent in 1993.

Table 1: Household categories of nutritional outcome

	1993	**%**	**1997**	**%**	**2000**	**%**	**2007**	**%**
Underweight	1,359	26.34	1,347	23.76	1,587	21.30	1,351	14.94
Normal weight	1,364	26.44	1,167	20.59	1,414	18.98	1,556	17.21
Dual burden	621	12.04	977	17.24	1,377	18.48	1,546	17.1
Overweight	1,815	35.18	2,177	38.41	3,073	41.24	4,587	50.74
Total	5,159	100	5,668	100	7,451	100	9,040	100

Source: IFLS1, IFLS2, IFLS3, IFLS4

Developments of the Theil index are presented in Table 2. The results show a constant rise over time, indicating increasing levels of intra-household nutritional inequality. This underlines that the dual burden classification, which has remained more or less constant since 1997, is not a very precise measure of intra-household nutritional inequality. Considering location, the Theil index is consistently higher in urban than in rural areas, albeit it has increased in all locations. The increase in rural areas was even more pronounced. This is surprising, because lifestyle changes usually tend to be more rapid in urban areas.

Figure 1 compares the two different measures of intra-household nutritional inequality more explicitly and disaggregates the Theil index by household category. In all survey waves, the Theil index was highest in dual burden households, which is as expected. Inequality within categories is lowest among normal weight followed by underweight households. In these categories, the index

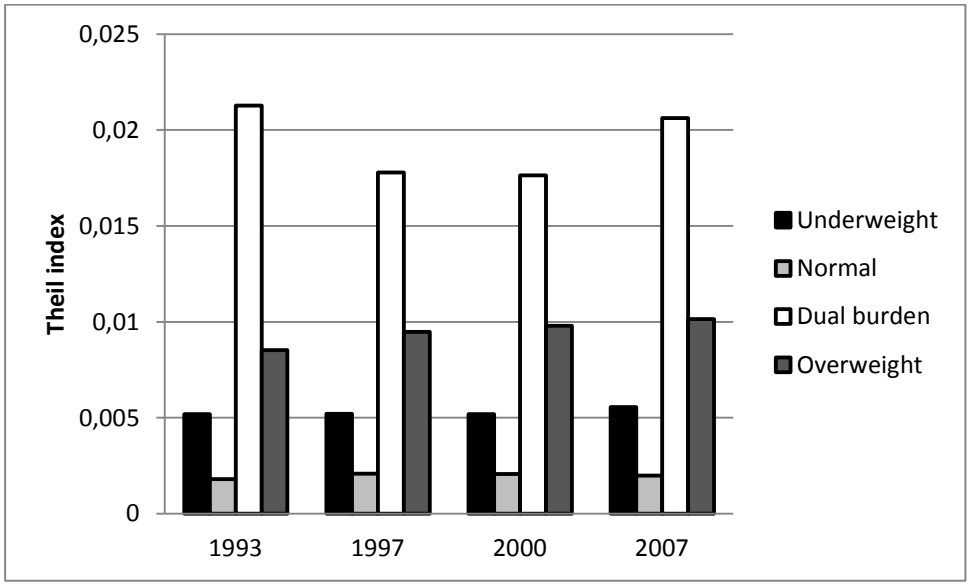
values remained almost constant over time. In contrast, in the overweight category significantly higher and rising values of the Theil index are observed, which points at rising levels of extreme obesity among some household members. Again, this analysis underlines that a discrete categorization of households has limits in terms of analyzing nutritional inequality.

Table 2: Theil index of intra-household nutritional inequality by location (mean values)

	Total	Rural	Urban
1993	0.0074	0.0063	0.0087
1997	0.0084	0.0074	0.0096
2000	0.0088	0.0077	0.0102
2007	0.0099	0.0090	0.0109

Source: IFLS1, IFLS2, IFLS3, IFLS4

Figure 1: Theil index of intra-household nutritional inequality by household category



Source: IFLS1, IFLS2, IFLS3, IFLS4

The analysis so far could have been carried out with repeated cross-section surveys. Table 3 exploits the panel structure of the IFLS data more explicitly, by tracking individual households over time. The transition matrix shown indicates what proportion of households in a particular category remained in the same category and what proportion moved to other categories in the subsequent period. Of all underweight households, 51 percent are still underweight in the next period, implying that almost half of them moved to other categories. Over 60 percent of the normal weight households

moved to other categories in the next period, most of them to the overweight group. Yet, 19 percent also moved to the underweight category, implying that the risk of undernutrition is still present for certain population segments.

Dual burden within households seems to be a transitory phenomenon, which is in contrast to findings of Jehn and Brewis (2009) who analyzed demographic and health surveys for a set of 18 developing countries. Our data show that the majority of the dual burden households in Indonesia moved to other categories in the next period, most of them to the overweight category. As seen above, this does not mean that the dual burden category gets smaller, because households from other categories move in. The most stable category is overweight. This is quite alarming and will be hard to reverse, especially at more extreme levels of obesity. These results point at a nutrition transition where the proportion of underweight households and individuals gets smaller, while the proportion of overweight people increases. Dual burden households seem to be an inherent part of this transition, because different age and gender cohorts are changing their body shapes at different velocity.

Table 3: Transition matrix of households in different categories (in %)

	Underweight	Normal	Dual burden	Overweight	Total
Underweight	50.94	17.73	17.41	13.91	100
Normal	18.71	38.18	9.54	33.58	100
Dual burden	11.8	7.01	43.52	37.66	100
Overweight	3.65	8.1	15.22	73.03	100
Total	19.37	16.78	19.08	44.77	100

Source: IFLS1, IFLS2, IFLS3, IFLS4

But who is overweight and who is underweight within households? Table 4 shows that in dual burden households children are more likely to be underweight than adults. Overweight rates are highest in the middle age cohorts between 30 and 50 years. The same holds true in overweight households. In contrast, in underweight households, the underweight members are equally distributed across all age cohorts. We also disaggregated by gender of the household members (results not shown in Table). For adults, overweight is more common in females and underweight is more common in males, which is in line with earlier research by Roemling and Qaim (2012). In overweight households,

girls are generally more overweight than boys. In purely underweight households, these differences between females and males are less pronounced.

Based on these descriptive results, we deduce that intra-household nutritional inequality is probably unintentional. If there were an intentional bias in food and health care allocation, we would expect to see a general preference of males over females, income earners over non-income earners, or children over adults. But this is not what we observe. Children and male adults are more likely to be underweight. Reasons for the observed inequality are probably rather dietary and lifestyle changes coupled with limited nutrition and health knowledge.

Table 4: Age structure of underweight and overweight in different household categories (mean number of household members in age cohorts)

	Dual burden (n=4521)		**Overweight (**n=11652)		**Underweight (**n=5644)	
Age cohort	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Underweight						
< 10	0.225	0.454	0	0	0.178	0.425
10 to 20	0.218	0.453	0	0	0.177	0.430
20 to 30	0.273	0.508	0	0	0.250	0.487
30 to 40	0.137	0.350	0	0	0.181	0.407
40 to 50	0.100	0.302	0	0	0.144	0.373
50 to 60	0.111	0.320	0	0	0.184	0.418
60 to 70	0.115	0.327	0	0	0.176	0.406
> 70	0.098	0.304	0	0	0.136	0.372
Overweight						
< 10	0.132	0.363	0.144	0.379	0	0
10 to 20	0.073	0.283	0.106	0.339	0	0
20 to 30	0.206	0.437	0.247	0.485	0	0
30 to 40	0.329	0.526	0.434	0.600	0	0
40 to 50	0.313	0.523	0.350	0.571	0	0
50 to 60	0.189	0.418	0.189	0.439	0	0
60 to 70	0.077	0.278	0.090	0.309	0	0
> 70	0.031	0.175	0.037	0.197	0	0

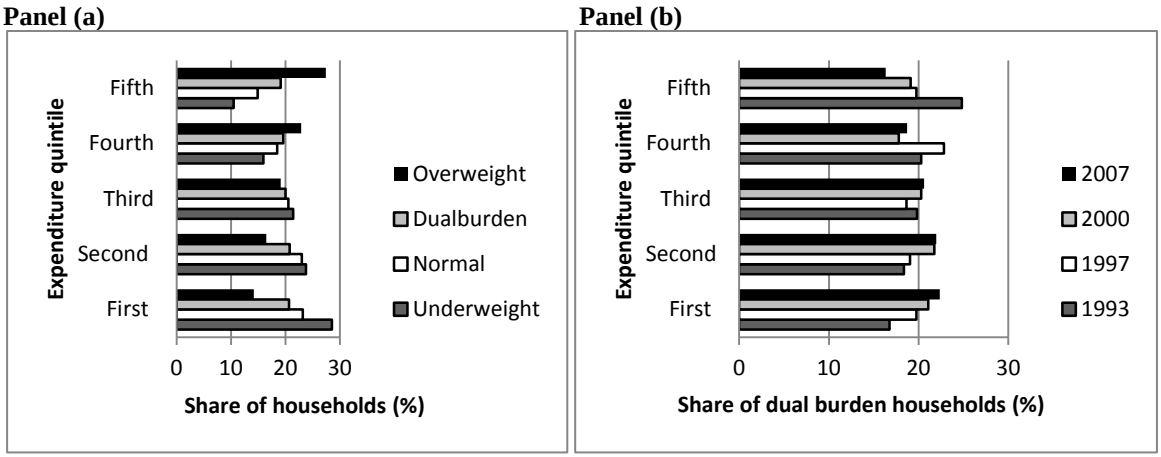
Source: IFLS1, IFLS2, IFLS3, IFLS4
Note: Pooled sample was used.

3.2 Descriptive analysis of socioeconomic factors

We now look at associations between nutritional inequality and socioeconomic factors. Figure 2 (panel a) looks at the distribution of household categories by expenditure quintile. Overweight households are more prevalent in the richer, whereas underweight households are more prevalent in the poorer population segments. Strikingly, dual burden households are distributed relatively equally across expenditure quintiles. The picture gets more nuanced when we look at the prevalence of dual burden separately for the four survey waves (panel b of Figure 2). In the first wave in 1993, the highest prevalence of dual burden households was observed in the richest, and the lowest prevalence in the poorest expenditure quintile. Over time, this pattern was reversed. In 2007, the poorest expenditure quintile had the highest proportion and the richest quintile the lowest proportion of dual burden households.

These trends suggest that the nutrition transition has initially started in the richer segments, but is now more and more also affecting the poorer population groups. The proportion of individuals affected by underweight is now low in the upper expenditure quintiles, so that also dual burden households are relatively rarely observed in these richer segments. In poorer households, the prevalence of underweight individuals is still larger. In these households, the dual burden phenomenon occurs as soon as individual members become overweight, which is now often observed. Hence, intra-household nutritional inequality is increasing among the poor, although the Theil index is still higher in upper expenditure quintiles. These dynamics support our finding that the dual burden phenomenon is of transitory nature. Such conclusions could not have been drawn from cross-section data alone. Doak et al. (2000) and Doak et al. (2005) showed that the dual burden phenomenon is more prevalent among the rich in some countries, while it is more prevalent among the poor in others. This is probably simply due to the fact that the nutrition transition started at different points in time across countries.

Figure 2: Household categories by expenditure quintile



Source: IFLS1, IFLS2, IFLS3, IFLS4
Note: Panel (a) refers to the pooled sample across all four survey waves. Panel (b) only includes dual burden households and shows developments over time.

Another interesting factor to look at is location. The Theil index indicates higher levels of intra-household nutritional inequality in urban than in rural areas. The same holds true for the discrete classification. Around 65 percent of dual burden and overweight households are located in urban areas, whereas only 45 percent of the normal and underweight households are located there. This is expected: urban location is generally associated with a greater variety of food choices, including processed convenience items and fast food meals, as well as jobs and hobbies involving lower levels of physical exercise.

The nutrition transition is characterized by an increasing share of animal products in household food expenditures and a decreasing share of traditional staple foods. Table 5 confirms that this change in food demand behavior is associated with rising levels of intra-household nutritional inequality. Households with a higher Theil index spend a significantly lower share of their food budget on rice and a higher share on meat and dairy products. Furthermore, a larger proportion of households with a high Theil index own a television. In Indonesia, television ownership is fairly widespread and not a good indicator for wealth anymore. We rather use television ownership as a proxy for little leisure time exercise. Hence, factors that are typical for the nutrition transition seem to contribute to rising intra-household inequality.

Table 5: Theil index and nutrition transition characteristics

	Theil index	Observations	Mean	Std. error	Significance
Rice share in total food expenditure	Low	13659	0.060	0.053	***
	High	13656	0.046	0.043	
Meat and dairy share in total food expenditure	Low	13659	0.151	0.117	***
	High	13656	0.168	0.119	
Television possession	Low	11075	0.600	0.490	***
	High	11075	0.730	0.444	

Source: IFLS1, IFLS2, IFLS3, IFLS4
Note: Theil index divided at the median into low and high. For 1993, no information about television possession was available. *** means that the difference in mean values between low and high Theil index groups is significant at the 1% level.

In terms of household structure, a higher Theil index and a greater prevalence of dual burden is observed in larger households with more members. This is plausible, because with more members the likelihood of larger BMI differences between individuals increases. A larger number of children is also associated with a higher likelihood of dual burden. Table 6 looks at gender patterns in terms of the household head. In the pooled sample, about 13 percent of all households are headed by females. Household headed by women are less likely to be classified as dual burden and overweight than households headed by men. Moreover, households headed by women have a somewhat lower Theil index. This may surprise on first sight, because overweight is more widespread among adult females than among adult males. But this refers to women in general, especially after marriage when their physical activity levels decrease due to cultural and religious norms in Indonesia. Female household heads are less likely to be overweight themselves, because they have to work and are also responsible for other physical tasks that would normally be performed by men in male headed households.

Table 6: Intra-household nutritional inequality and gender of household head

	Household head	Observations	Mean	Std. error	Significance
Dual burden household	Male	23844	0.169	0.375	***
	Female	3474	0.142	0.349	
Overweight household	Male	23844	0.432	0.495	***
	Female	3474	0.386	0.487	
Theil index	Male	23844	0.0089	0.0104	*
	Female	3474	0.0085	0.0103	

Source: IFLS1, IFLS2, IFLS3, IFLS4

3.3 Regression analysis

In the regression analysis, we explain intra-household nutritional inequality using the socioeconomic characteristics discussed above as explanatory variables. We start with a probit model to explain the dual burden phenomenon against all other household categories combined. Results are shown in column (1) of Table 7. When the household head has an occupation that involves heavy physical work, the household is less likely to be a dual burden household. Moreover, female headed households are less likely to be affected by the dual burden phenomenon, which confirms the descriptive analysis above. Rural location has a negative effect, while household size increases the probability of being a dual burden household. This is also in line with the descriptive analysis. Interestingly holding household size, average household age, and the number of children constant, the number of working household members has s positive and significant effect. This may be explained by the fact that working household members spend less time on child care, which may potentially result in lower quality and less balanced diets for children. As mentioned, in dual burden households it is often the children who are underweight, while adults tend to be overweight. The time dummies are all positive, significant, and rising in magnitude in later survey waves, suggesting that unobserved factors tend to increase the probability of dual burden over time.

The second column in Table 7 shows dual burden households compared with normal and underweight households. The signs and significance levels are similar to those in column (1). In addition, all education variables are positive and significant. This is surprising and underlines that school education does not necessarily lead to more nutrition and health knowledge. Moreover, household expenditure increases the probability of dual burden. While the lowest expenditure quintile now has the highest prevalence of dual burden households (see above), this was different in previous survey waves which are also included in this regression. In addition, we now control for other socioeconomic factors that are correlated with expenditure.

Table 7: Panel random effects probit estimation for household categories (marginal effects)

	(1) Dual burden		(2) Dual burden-normal/underweight		(3) Dual burden-overweight	
Primary school	0.00832	(1.093)	0.0366**	(2.341)	-0.0234	(-1.353)
Secondary school	0.0167*	(1.809)	0.0848***	(3.982)	-0.0204	(-1.056)
Tertiary education	0.00364	(0.299)	0.155***	(3.977)	-0.0549**	(-2.551)
Light work	0.00150	(0.151)	0.00355	(0.144)	0.000899	(0.0467)
Medium work	0.00232	(0.225)	-0.0275	(-1.162)	0.0246	(1.180)
Heavy work	-0.0299***	(-3.044)	-0.104***	(-4.414)	-0.0159	(-0.767)
Housekeeping	0.00592	(0.423)	-0.0245	(-0.857)	0.0402	(1.332)
Unemployed	0.0284	(1.494)	-0.00735	(-0.212)	0.0995**	(2.450)
Retired	0.0221	(1.472)	0.00106	(0.0338)	0.0697**	(2.294)
Female household head	-0.0170**	(-2.438)	-0.0483***	(-3.390)	-0.0213	(-1.336)
Age of household head	0.00164***	(6.298)	0.00450***	(8.105)	0.00271***	(4.754)
Monthly expenditure	0.000136	(0.0396)	0.0667***	(8.641)	-0.0520***	(-7.120)
Rural location	-0.0194***	(-3.623)	-0.0971***	(-7.579)	0.00895	(0.791)
Household size	0.0296***	(17.06)	0.0754***	(18.84)	0.0436***	(12.04)
Mean household age	-0.000641**	(-2.090)	-0.00150**	(-2.339)	-5.19e-05	(-0.0765)
Working household members	0.0178***	(6.990)	0.0424***	(7.378)	0.0284***	(5.371)
Number of children	-0.000280	(-0.105)	0.00134	(0.229)	0.00310	(0.543)
Dummy 1997	0.0466***	(6.054)	0.109***	(6.907)	0.0519***	(3.541)
Dummy 2000	0.0665***	(8.735)	0.171***	(10.70)	0.0592***	(4.233)
Dummy 2007	0.0698***	(9.469)	0.246***	(14.41)	0.0251*	(1.885)
Observations	27,318		15,666		16,173	
Number of groups	11,242		7,907		8,231	

Source: IFLS1, IFLS2, IFLS3, IFLS4

Notes: z-statistics are shown in parentheses. ***, **, and * means significant at the 1%, 5%, and 10% level, respectively. Province dummies were included in estimation, but are not shown here. Expenditures are adjusted by the consumer price index. The base category for education of the household head is "no education". The base category for the household head occupation is "sedentary work".

Table 8: Panel regressions explaining the Theil index

	(1) Random effects		(2) Fixed effects	
Primary school	0.0902**	(2.403)	-0.00437	(-0.0895)
Secondary school	0.141***	(3.297)	0.0112	(0.170)
Tertiary education	0.172***	(3.082)	-0.134	(-1.361)
Light work	-0.0514	(-1.240)	0.0296	(0.509)
Medium work	-0.119***	(-2.777)	-0.0407	(-0.675)
Heavy work	-0.216***	(-4.857)	0.0117	(0.189)
Housekeeping	-0.0866	(-1.432)	0.0184	(0.245)
Unemployed	-0.166**	(-2.239)	-0.0861	(-0.974)
Retired	-0.0958	(-1.576)	0.0656	(0.880)
Female household head	-0.194***	(-5.021)	-0.292***	(-5.935)
Age of household head	0.0216***	(16.27)	0.0155***	(9.219)
Monthly expenditure	0.0742***	(4.627)	0.0123	(0.592)
Rural location	-0.169***	(-6.774)	-0.0836	(-1.533)
Household size	0.142***	(17.39)	0.139***	(13.40)
Mean household age	-0.0290***	(-17.66)	-0.0327***	(-18.74)
Working hh members	0.0236**	(2.160)	0.00409	(0.293)
Number of children	0.0667***	(5.661)	0.0455***	(3.070)
Dummy 1997	0.245***	(9.529)	0.293***	(10.66)
Dummy 2000	0.324***	(12.31)	0.405***	(14.47)
Dummy 2007	0.464***	(16.36)	0.651***	(19.86)
Constant	-7.326***	(-33.95)	-6.578***	(-19.66)
Observations	27,318		27,318	
R-squared	0.125		0.110	
Number of groups	11,242		11,242	

Source: IFLS1, IFLS2, IFLS3, IFLS4
Note: ***,** , and * means significant at the 1%, 5%, and 10% level, respectively. Province dummies were included in estimation but are not shown here. Expenditures are adjusted by the consumer price index. The base category for education of the household head is "no education". The base category for occupation of the household head is "sedentary work".

In column (3) of Table 7, the comparison group is overweight households. Here, some of the results are different, which should not surprise, because now the question is whether additionally to overweight members there are also underweight members in the same household. Tertiary education of the household head reduces the probability of dual burden, while unemployment and retirement increase the probability. The expenditure effect is reversed. Higher household expenditures decrease

the probability of dual burden. In other words, richer households are more likely to be overweight. Female household head, rural location, and mean household age are no longer significant in this model. Table 8 shows the Theil index regressions. The dependent variable has been log transformed to improve statistical properties and facilitate interpretation. The first column shows the estimates of the random effects model. Many of the effects have the same sign as in the probit regressions above. Higher education of the household head is associated with higher intra-household inequality, again underlining that education is not a good proxy for nutrition and health knowledge. A possible explanation is that households with better educated heads may enter the nutrition transition and adopt western lifestyles more rapidly.

Higher physical work occupation of the household head has a negative effect. Medium and heavy physical work reduce the Theil index by 12 and 22 percent, respectively. Interestingly, unemployment has a negative effect as well. Higher consumption expenditures contribute to higher levels of intra-household nutritional inequality. Female headed households have an almost 20 percent lower Theil index than male headed households. On the one hand, this may be due to the fact that female household heads are less likely to be overweight themselves, as discussed above. On the other hand, their children are also less likely to be underweight. Different studies have shown that female controlled income often has more positive effects on child nutrition than male controlled income due to differences in spending behavior (e.g., Rogers, 1996; Thomas, 1990).

The second column in Table 8 shows the fixed effects estimates. Many of the explanatory variables that are almost time-invariant within individual households lose their statistical significance. This is characteristic for fixed effects models and does not necessarily imply that these variables are economically insignificant. Other variables such as female household head, age, and number of children remain significant. The fixed effects results imply that female headed households have an almost 30 percent lower Theil index than male headed households on average. In both models in Table 8, the time dummies have relatively large positive and increasing coefficients. This suggests that intra-household nutritional inequality increases over time, even beyond the effects of rising living standards and urbanization tendencies that are already controlled for.

4 Conclusion

We have analyzed the phenomenon of dual burden households in Indonesia with four waves of panel data covering the period from 1993 to 2007. Around 17 percent of all households in Indonesia are currently classified as dual burden, meaning that they have both underweight and overweight members. This proportion increased between 1993 and 1997, but remained relatively stable since then. However, this stable proportion does not imply that individual households would remain in the dual burden category for long. On the contrary, the majority of the dual burden households in one period are not dual burden anymore in the next period. This shows that dual burden is a transitory phenomenon in Indonesia, which is associated with dietary and lifestyle changes in the nutrition transition. These dietary and lifestyle changes affect the BMI, but apparently different age cohorts are affected at different velocity. In dual burden households it is often children who are underweight, while adults – and female adults in particular – are overweight. The dual burden phenomenon started in the richer population segments, but over time it moved down the income ladder. Today, the highest prevalence of dual burden households is observed in the lowest expenditure quintile. Most households that escape the dual burden category move into the overweight category, where they tend to stay. Hence, the problems of overweight and obesity, which are already quite significant in Indonesia, will further increase in the future. Such dynamics could not have been analyzed with cross-section data.

Another innovation that we introduced to the study of dual burden is the development and use of a continuous Theil index of intra-household nutritional inequality. Unlike the dual burden classification, for which the prevalence has remained constant since 1997, the Theil index has increased steadily over time. The reason is that intra-household nutritional inequality is also rising within household categories, especially among the overweight. Rising intra-household nutritional inequality makes policy design more complex, because food and nutrition interventions need to be targeted more specifically at individuals or subgroups within households.

The regression analysis has shown that urban location, number of children, and overall household consumption expenditures increase intra-household nutritional inequality. Paradoxically, better education of the household head also contributes to a higher Theil index. Obviously, school and university education are not a guarantee for good nutrition and health knowledge. Curricula will need

to be adjusted to cover such important topics. Moreover, broader awareness campaigns for healthy nutrition and lifestyles could be developed. Indonesian policy-makers and the wider public understand the need to address undernutrition, whereas overnutrition is not yet sufficiently recognized as a serious public health problem. Strengthening the role of women within families and society at large can be an important component. Our results demonstrate that households with female decision-makers have significantly lower levels of nutritional inequality.

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6 Appendix

Table A1: Summary statistics of pooled sample

	Mean (n=27318)	St.dev.	Min	Max
Education of household head				
No education	0.117	0.322	0	1
Primary school	0.490	0.500	0	1
Secondary school	0.323	0.468	0	1
Tertiary education	0.070	0.255	0	1
Occupation of household head				
Sedentary work	0.048	0.214	0	1
Light work	0.254	0.435	0	1
Medium work	0.219	0.414	0	1
Heavy work	0.343	0.475	0	1
Housekeeping	0.062	0.242	0	1
Unemployed	0.022	0.147	0	1
Retired	0.051	0.221	0	1
Female household head	0.127	0.333	0	1
Age of household head	45.39	13.86	17	102
Monthly expenditure (log)	12.534	0.751	9.41	16.69
Rural location	0.533	0.499	0	1
Household size	4.427	1.822	2	16
Mean age of household	30.51	13.03	9.2	99
Working hh members	1.575	0.919	0	8
Number of children	1.392	1.191	0	8

Source: IFLS1, IFLS2, IFLS3, IFLS4
Note: Expenditures are adjusted for Consumer Price Index.