Römling, Cornelia; Qaim, Matin

Conference Paper

Direct and Indirect Determinants of Obesity: The Case of Indonesia

Proceedings of the German Development Economics Conference, Berlin 2011, No. 70

Provided in cooperation with:
Verein für Socialpolitik

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

GlobalFood
www.uni-goettingen.de/globalfood

RTG 1666 GlobalFood

Transformation of Global Agri-Food Systems:
Trends, Driving Forces, and Implications for Developing Countries

Georg-August-University of Göttingen

GlobalFood Discussion Papers

No. 4

Direct and Indirect Determinants of Obesity: The Case of Indonesia

Cornelia Römling
Matin Qaim

June 2011

RTG 1666 GlobalFood · Heinrich Düker Weg 12 · 37073 Göttingen · Germany
www.uni-goettingen.de/globalfood

ISSN (2192-3248)

Direct and Indirect Determinants of Obesity: The Case of Indonesia

Cornelia Römling [a*] and Matin Qaim [a]

[a] Department of Agricultural Economics and Rural Development, Georg-August-University of Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany

[*] Author of correspondence, croemli@gwdg.de, tel: +4955139445,fax: +49551394823

June 2011

Abstract:

Overweight and obesity are becoming serious issues in many developing countries. Since undernutrition is not completely eradicated yet, these countries face a dual burden that obstructs economic development. We analyze the nutrition transition in Indonesia using longitudinal data from the Indonesian Family and Life Survey, covering the period between 1993 and 2007. Obesity has been increasing remarkably across all population groups, including rural and low income strata. Prevalence rates are particularly high for women. We also develop a framework to analyze direct and indirect determinants of body mass index. This differentiation has rarely been made in previous research, but appears useful for policy making purposes. Regression models show that changing food consumption patterns coupled with decreasing physical activity levels during work and leisure time directly contribute to increasing obesity. Education, income, and marital status are significant determinants that influence nutritional status more indirectly. Change regressions underline that there are important path-dependencies. From a policy perspective, nutrition awareness and education campaigns, combined with programs to support leisure time exercise, seem to be most promising to contain the obesity pandemic. Women should be at the center of policy attention.

Keywords: Obesity, Overweight, Nutrition Transition, Asia, Indonesia

JEL: I10, O12

Acknowledgements: We gratefully acknowledge helpful comments from Holger Seebens, Stephan Klasen, and Walter Zucchini.

Direct and Indirect Determinants of Obesity: The Case of Indonesia

Abstract:

Overweight and obesity are becoming serious issues in many developing countries. Since undernutrition is not completely eradicated yet, these countries face a dual burden that obstructs economic development. We analyze the nutrition transition in Indonesia using longitudinal data from the Indonesian Family and Life Survey, covering the period between 1993 and 2007. Obesity has been increasing remarkably across all population groups, including rural and low income strata. Prevalence rates are particularly high for women. We also develop a framework to analyze direct and indirect determinants of body mass index. This differentiation has rarely been made in previous research, but appears useful for policy making purposes. Regression models show that changing food consumption patterns coupled with decreasing physical activity levels during work and leisure time directly contribute to increasing obesity. Education, income, and marital status are significant determinants that influence nutritional status more indirectly. Change regressions underline that there are important path-dependencies. From a policy perspective, nutrition awareness and education campaigns, combined with programs to support leisure time exercise, seem to be most promising to contain the obesity pandemic. Women should be at the center of policy attention.

1 Introduction

For quite some time, overweight and obesity were considered primarily problems of developed countries. However, with increasing incomes, urbanization, and changing lifestyles, it is obvious that developing countries are facing the same issues (Popkin, 2001, 2004). A major difference is that in developing countries relatively little attention is paid to the problem of excessive weight gain by policymakers; it is still perceived rather positively and associated with higher social status. Given that obesity contributes to a variety of serious chronic diseases and thus to a large health burden (e.g., WHO, 2000; Martorell et al., 2000; Popkin et al. 2001), its spread hampers human welfare and economic development. Developing countries that already have high obesity prevalence rates are mainly found in Latin America (Albala et al., 2002; Uauy et al., 2001; Vio et al., 2008) and the Middle East and North Africa (Martorell et al., 2000; Mokhtar et al., 2001). But also in Asia and Sub-Saharan Africa, where undernutrition is still more prevalent, obesity is rising, causing a double burden of malnutrition. The reason for this paradox is seen in the so-called nutrition transition. This term comprises food consumption and physical activity changes that are associated with lifestyle transformations in modernizing or westernizing societies (Popkin, 2001). Whereas in developed countries this process occurred gradually, in many developing countries it currently seems to take place within a much shorter time frame (Popkin, 2004). Containing the obesity pandemic through appropriate policies requires a better understanding of the trends and their underlying determinants in particular settings.

The literature on socioeconomic aspects of obesity is growing, but many of the studies focus on developed countries (Lakdawalla and Philipson, 2009; Offer et al., 2010). These findings are also interesting for developing countries, but they cannot be extrapolated directly, because of very different framework conditions. More recently, a number of studies have also focused on developing countries. Subramanian et al. (2011) have used Demographic and Health Surveys of several low and middle income countries to analyze the relationship between socioeconomic status and weight change. Their results confirm earlier findings by Subramanian and Smith (2006), who found a positive association between socioeconomic status and overweight in India. Abdulai (2010) found work-related physical activity, income, and education as important influencing factors of obesity for women in urban Ghana. Valeggia et al. (2010) focused on indigenous populations in Argentina, demonstrating the importance of social, cultural, and political variables for nutritional status. Paeratakul et al. (1998) undertook cross-sectional as well as longitudinal analyses for China, using socioeconomic, dietary, as well as physical activity variables. A more recent study for China analyzed the importance of food prices for body fat (Lu and Goldman, 2010). Similarly, Asfaw (2007) examined the impacts of food price subsidies on obesity in Egypt. Huffman and Rizov (2010) used an extensive set of variables to analyze the situation in Russia and found higher education as a possible entry point to lower obesity.

One problem related to previous research in developing countries is that most studies build on cross-sectional data, such that obesity trends and nutritional shifts over time have rarely been analyzed. Notable exceptions include Paeratakul et al. (1998) and Bell et al. (2001) for China. A second problem is the lack of a clear conceptual framework that distinguishes between direct and indirect determinants. For instance, socioeconomic status expressed by income or education will mostly affect nutritional outcomes indirectly through food consumption and physical activity levels, which will then influence body weight. Some previous studies included indirect factors only, which may potentially lead to omitted variable bias, as direct and indirect factors are correlated. Other studies included both types of variables, but without explicitly differentiating, thus failing to uncover certain effects and causal mechanisms. One exception is Case and Menendez (2009), who differentiated between underlying and immediate effects in their analysis for South Africa.

We contribute to the literature by analyzing nutritional developments over time and differentiating between direct and indirect determinants, using descriptive analysis and regression models. The empirical focus is on Indonesia, which we consider an interesting example for several reasons. First, Indonesia is a large and populous country and one of the economically fast growing nations of Asia. Second, rapid urbanization and a transformation of traditional food systems towards modern supply chains can be observed (World Bank, 2007). Third, recent research showed that obesity rates are increasing in Indonesia (Usfar et al., 2010). Moreover, Lipoeto (2004) revealed a notable shift in causes of death from infections to cardiovascular diseases. Fourth, unlike China and India, for which more research is already available, Indonesia is a Muslim country, which may play a

role for the direction of lifestyle changes, especially also when considering gender differences. Thus, Indonesia may offer interesting insights into developments that are likely to occur also in several other Asian countries that are still at earlier stages of economic development.

The rest of this paper is structured as follows. The next section discusses the conceptual framework and the data from Indonesia. Then, we present different descriptive analyses, focusing on obesity trends and differentiating between male and female adult populations. Subsequently, we develop and estimate different econometric models, including cross-section and change regressions to analyze direct and indirect obesity determinants. The last section concludes and discusses policy implications.

2 Analytical Approach and Data

2.1 Conceptual Framework

The basic idea of our analysis is to build a conceptual framework of weight and weight gain. Simply said, the nutritional status of a person is the result of calorie input and calorie usage (Rosin, 2008).

nutritional status = calorie input – calorie usage

Different factors are influencing both right-hand-side variables. The individual's nutritional status depends on his/her preferences for food, physical activity, and body appearance, but also on possible income constraints and environmental conditions. For example, labor market conditions affect the types of jobs available, and infrastructure determines the accessibility of goods and the strenuousness of daily life.

Figure 1 shows the determinants of nutritional status, which we measure in terms of body mass index (BMI). We differentiate between direct and indirect factors. A similar framework has already been used in undernutrition research. For example, Caputo et al. (2003) and Smith and Haddad (2000) used similar concepts where income is an intermediate factor that influences dietary intake, whereas dietary intake then influences nutritional status. Differentiating between direct and indirect determinants helps to better understand the channels of influence and facilitates the interpretation of empirical results. Direct influencing factors are only those that directly change calorie input and calorie usage.

Calorie input is a function of food consumption, including aspects of both food quantity and composition (Popkin and Gordon-Larsen, 2004). For instance, the more fat and sugar the diet contains, the higher is the risk of gaining excess weight. This is often associated with highly processed foods and beverages. With rising incomes, urbanization, global advertising, and the spread of supermarkets and fast-food outlets, an increasing number of households consume meat, dairy

products, and highly processed convenience and junk foods, replacing traditional foods with higher fiber contents (Popkin, 1999).

Calorie usage, on the other hand, primarily depends on physical activity during work and leisure time. Decreasing employment in agriculture, urbanization, and a general trend towards a service sector economy imply lower physical occupational activity, a process that occurs at high speed in many developing countries (Monda et al., 2007). Sometimes, leisure time is used for sports and other physical exercise, which is less common in many developing countries, however, due to climatic and cultural factors. At the same time, physical activity in leisure time is lowered through the increasing popularity of television, videogames, and the internet. The strenuousness of household work is another aspect to consider. Household work becomes easier in the process of economic development, due to wider availability of electricity, piped water, private means of transportation, and household appliances such as washing machines, fridges, and vacuum cleaners.

Apart from food consumption and physical activity, genetic factors may directly influence nutritional status (Philipson, 2001). Genetic factors are not easy to measure, however, in socioeconomic research. Likewise, past individual nutritional experiences may affect present and future nutritional outcomes through body programming. Studies suggest that people who suffered prenatal nutritional deficiencies or undernourishment during childhood are more susceptible to obesity and associated chronic diseases when their nutritional situation improves later on (Adams et al., 2003; Kaiser et al., 2004; Offer et al., 2010; Popkin et al., 1996). This is particularly relevant for developing countries that undergo the nutrition transition in a relatively short period of time.

Indirect factors, which are expected to affect nutritional status mostly through their influence on food consumption and physical activity, are socioeconomic variables, such as income, education, and other household demographics. Especially in developing countries, where undernutrition is still widespread, higher incomes and better education are expected to contribute to more food consumption. On the other hand, both variables are likely contributing to less physical activity during work and partly also during leisure time for reasons explained above. Location is also an important indirect factor, as this may influence food accessibility and physical activity. For instance, in rural areas infrastructure conditions are usually worse than in urban areas, so that walking longer distances is more common. And finally, smoking may affect food consumption by reducing appetite; it may also influence calorie usage directly by increasing body metabolism (Soares et al., 1998). Another factor with direct as well as indirect influences is the age of the individual. Apart from inducing behavioral changes for example decreasing physical activity with increasing age, the basal metabolism and body composition is changing with age (Elia, 2001; Speakman and Westerterp, 2010).

In our empirical approach, we will estimate regression models with BMI, or change in BMI, as dependent variable and the various influencing factors as independent variables. In order to better understand causal mechanisms, we will use models where we include direct and indirect factors

separately and other models where we include them jointly. This is important, because variables classified as indirect factors may potentially also have direct effects on BMI, as indicated by the dotted arrow in Figure 1. As mentioned above, the differentiation between direct and indirect factors has rarely been made in previous research.

2.2 DATA

Our analysis of nutritional status and change over time in Indonesia builds on data from the Indonesian Family and Life Survey (IFLS) of the Rand Institute. IFLS survey waves were conducted in 1993, 1997, 2000, and 2007, offering a panel structure. While in the sampling framework a few remote areas were not included, the data are representative for 83% of the Indonesian population. Out of a total of 27 provinces, 13 were selected for the IFLS, including four provinces in Sumatra (North Sumatra, West Sumatra, South Sumatra, and Lampung), all five provinces in Java (DKI Jakarta, West Java, Central Java, DI Yogyakarta, and East Java), and the four provinces Bali, West Nusa Tenggara, South Kalimantan, and South Sulawesi.[1] The survey includes data on health aspects, anthropometric measurements of adults and children, and detailed information on various socioeconomic characteristics, including household level assets and expenditures, and individual level employment.

Our analysis concentrates on male and female adults aged 20 to 75. We do not include children and adolescents, because the nutritional situation and determinants are very different. We for example focus especially on work related physical activity which is not part of children's life. Further, for children the BMI is not a good measure of nutritional status in this pure way; adaptations would be needed to make the nutritional status comparable. We use data from three of the four IFLS waves, namely 1993 (IFLS1), 2000 (IFLS3), and 2007 (IFLS4). We decided not to use the 1997 (IFLS2) data for two reasons. First, in 1997 Indonesia was undergoing a severe economic and financial crisis. This affected household expenditures and other relevant variables and could lead to ambiguous results in the analysis. Second, focusing on 1993, 2000, and 2007 offers the advantage of equal time intervals between the waves.

Table 1 shows the sample size of male and female adult individuals in the three waves. The sample size has grown over time, because additional household members were included (such as adolescents that reached the age limit of 20), and split-off households were tracked in the survey. The sample used for our analysis is somewhat smaller than the complete adult sample in the IFLS waves, because we only consider those individuals for whom complete data on all variables of interest are available.

[1] For further information on the sampling scheme see (Frankenberg and Karoly, 1995; Strauss et al., 2004; Strauss et al., 2009).

3 Descriptive Analysis

3.1 BMI TRENDS

The BMI – defined as the body weight in kilograms divided by the squared body height in meters – is used here as the indicator of nutritional status. It should be mentioned that the BMI has some drawbacks in identifying body fat and obesity for people of certain stature; yet it is the most widely used indicator and the only one for which comparable data are usually available (WHO, 2000).

Table 2 shows that the mean BMI in Indonesian adults has increased notably since 1993. This trend is similar to the one observed in China and other fast emerging countries in Asia (Lu and Goldman, 2010; Paeratakul et al., 1999) although the mean BMI in Indonesia is higher than in countries like Cambodia, India, or Tibet (Subramanian et al., 2011). Women in Indonesia have a higher mean BMI than men, with the difference growing over time. This gender difference is more pronounced than in China. Table 2 also shows differences between rural and urban areas in Indonesia. While rural men and women have a lower mean BMI, the increase over time is stronger than among the urban population. An increase in BMI may indicate either an improvement or a deterioration of nutrition status, depending on the starting point. Further analysis requires classification of individuals according to BMI categories.

BMI categories and cut-off levels for undernourished, normal, and overweight individual have been set internationally based on a Caucasian reference population. However, this Caucasian reference population may not properly reflect the situation for other ethnic groups. Research suggests that increased risk of chronic diseases and overweight-related mortality is associated already with lower BMI levels in Asians than in other populations (WHO, 2004). Gurrici (1998) calculated the cut-off value for obesity in the Indonesian populations at 27 (instead of 30). Using this in combination with data from WHO (2004), we categorize a BMI of higher than 27 as obese, and between 23 and 27 as preobese. These two categories together – i.e., the population with a BMI over 23 – are also referred to as overweight. Accordingly, a BMI between 18.5 and 23 is categorized as normal weight, whereas less than 18.5 is considered underweight. Figure 2 shows that the share of preobese and obese individuals in Indonesia has increased remarkably since 1993. At the same time, the share of underweight people has decreased, yet at lower pace, so that a declining proportion is classified as normal weight. This clearly illustrates that a dual burden of malnutrition is emerging in Indonesia, where undernutrition coexists with overnutrition.

Table 3 provides a breakdown of these developments by gender. While the prevalence of underweight is similar for men and women, this is clearly not the case for the other BMI categories. Already in 1993, overweight rates were significantly higher for women than for men, and this trend continued over time. In 2007, about 50% of all women in the sample were overweight; 20% were obese. In comparison, around 30% of the adult men in Indonesia are classified as overweight, and less

than 10% as obese. Higher obesity rates among women are in line with data from many other countries (Case and Menendez, 2009) and can partly be explained by biological factors. Women seem to have a higher propensity to store fat (Paeratakul et al., 1999). Furthermore, after pregnancy women often have the problem of losing excess weight they gained. But there are also cultural factors, related to the type of work and leisure activities that is acceptable for women in certain societies (Hansford, 2010). Especially in Muslim countries, women are sometimes less free to do sports and other physical exercises, which may raise the likelihood of accumulating excess weight.

Compared with other developing countries, Indonesian overweight rates in 1993 were similar to values observed in Brazil, China, and India at the same time. Also the rates in 2000 were similar to Brazil and China, but not to India anymore, since in India the nutrition transition has started much later. Even today, India still has high underweight rates and relatively low overweight rates (Gaiha et al., 2010; Shetty, 2002). By contrast, in a few other middle income countries, such as South Africa and Peru, or in transition countries such as Russia, the nutrition transition has started earlier than in Indonesia (Huffman and Rizov, 2010; Monteiro et al., 2004).

Table 4 takes a somewhat different perspective and considers how the BMI of individuals has changed over time, namely from 1993 to 2000 and from 2000 to 2007. The mean change was positive in rural and urban locations and in both time periods. Furthermore, it increased from the first to the second time period, suggesting that the nutrition transition has accelerated after 2000. The change was bigger for women than for men. Figure 3 visualizes the changes over time and reveals that the BMI distribution has become flatter between 1993 and 2007 for men and women. The distribution has also become more skewed to the right, indicating that those who started already further to the right increased their BMI over-proportionally. Similar general developments over time were also reported in a few other countries, including the USA and China (Penman and Johnson, 2006; Wang et al., 2007). In urban areas, where the nutrition transition usually starts, the distribution in Figure 3 is much flatter than in rural areas. Also, it is flatter for women than for men, which was true already in 1993. However, the most remarkable change between 1993 and 2007 is observed for women in rural areas, contradicting the widely held notion that the nutrition transition is confined to urban settings. In Indonesia, overweight and obesity are increasingly also becoming problems in rural locations.

Income and socioeconomic status contribute to higher BMIs in developing countries (Fernald, 2007; Ma, 2010). However, assuming that only the richer population segments would drive the trend, while the poor would be excluded from the nutrition transition is too simplistic. In Appendix 1 we show the BMI distribution for 1993 and 2007 disaggregated by expenditure quintiles. While changes in the distribution are relatively small for the poorer male quintiles, the flattening and rightward skewness over time are clearly visible across all female quintiles. Again, developments in rural areas are more pronounced than in urban areas.

After having examined BMI distributions and developments over time, in the following we will discuss the two main direct influencing factors, food consumption and physical activity. Since

there are no exact data for these two factors in the survey, we will use proxies, which are first explained before analyzing how they are correlated with nutritional outcomes.

3.2 FOOD CONSUMPTION

We proxy individual level food consumption with household per capita food expenditure data. In the IFLS, food expenditures are captured in terms of the value of consumption during one month measured in Indonesian rupiah. In addition to market purchases, the value of home-produced foods and food transfers is also considered. Expenditures were asked for different products and then pooled for product groups like meat, staple food, and fruits and vegetables. We are aware of the fact that per capita food expenditures are only a relatively crude proxy for individual level food consumption or intake, since important aspects such food quality, waste, and intra-household distribution cannot be accounted for. Unfortunately, other consumption data are not included in the survey.

Table 5 compares food expenditures for overweight and non-overweight individuals. Total food expenditures are significantly higher for the overweight population, as one would expect. Beyond overall consumption levels, we are also interested in dietary composition, which we measure through food expenditure shares of particular food groups. The first group of interest comprises meat and dairy products. As rising living standards and changing lifestyles are often associated with higher demand for animal products, we expect a higher expenditure share to indicate a more advanced stage of the individual nutrition transition. Indeed, Table 5 shows that overweight individuals spent significantly more on meat and dairy products than their non-overweight counterparts in 2007. Somewhat surprisingly, the expenditure shares for meat and dairy have not changed much since 1993, which may partly be due to inaccuracies in categorizing processed foods, the consumption of which has increased over time. Strikingly, however, the proportion of households consuming meat increased from 76% in 1993 to 91% in 2007, while the proportion of households consuming dairy products increased from 63% to 83%.

The second food group of interest is staple food, which in our categorization captures rice, corn, flour, and root and tuber crops, but not further processed foods such as noodles and bread. Unprocessed staples play a bigger role in traditional diets and are expected to lose in relative importance in the nutrition transition. Table 5 confirms a lower staple food expenditure share among overweight individuals. No significant differences were found in fruit and vegetable expenditure shares. Since Indonesia is a Muslim country, alcohol consumption is very low and therefore not further considered here. Unfortunately, further information about the sugar and fat content of foods and diets, which is expected to increase in the course of the nutrition transition, is not available in the dataset.

3.3 PHYSICAL ACTIVITY

Physical activity can be subdivided into work-related and leisure-related types. To proxy work-related activity, we use information about the occupation of individuals included in the survey. The data contain 100 different occupation codes, which we categorize into four physical activity groups building on classification system used previously (Lu and Goldman, 2010; Norman et al., 2002). These four groups are sedentary jobs, and jobs with light, medium, and heavy physical activity. As not all individuals are working, two additional categories for housekeeping and unemployed are used.

Figure 4 shows that there is an association between work-related physical activity levels and BMI categories. Individuals with sedentary jobs and those in housekeeping are more likely to be obese or preobese, whereas those who have higher physical activity levels in their work are more likely to be of normal weight or underweight. For the unemployed, the prevalence rates in the different BMI categories are similar to those who have jobs with heavy physical activity, albeit this may be due to income constraints.

Leisure-time physical activity includes household work and real free time that can be used for hobbies and pleasure. The strenuousness of household work is influenced by the ownership of household appliances such as washing machines, vacuum cleaners, and fridges. The value of household appliances was captured in the survey and is used here as one proxy. Unfortunately, pleasure activities are not properly captured in the data. We use a dummy that measures whether or not a household possesses a television. Although an imperfect measure, ownership of a television increases the tendency towards more sedentary lifestyles and may reduce the time spent on more active hobbies (Popkin and Gordon-Larsen, 2004). The lower part of Table 5 confirms that the household appliances and television variables both show significantly higher mean values for overweight households.

Correlation coefficients between BMI, total per capita household expenditures as our key indicator of living standard, as well as food consumption and physical activity variables are shown in Table 6. All correlations are statistically significant and with the expected signs. These and other relationships are further scrutinized in the following, using regression analysis.

4 Regression Analysis

4.1 CROSS-SECTION REGRESSIONS

We start the regression analysis by focusing on the cross-section sample of adult individuals in 2007, as this is the most recent survey wave, where prevalence rates of overweight and obesity were already much higher than in previous waves. We use the BMI as the dependent variable, which we want to explain as a function of direct and indirect influencing factors, as outlined in the conceptual framework section above. We estimate separate models for male and female individuals. Given the

results from the descriptive analysis, gender differences in the estimation coefficients may be expected. The different models discussed below are estimated with ordinary least squares (OLS) techniques. Robust standard errors are used, because tests showed that the models are heteroscedastic. Moreover, standard errors are cluster corrected at community and household levels, to control for possible error correlation.

Before discussing the estimation results, Table 7 shows descriptive statistics for the dependent and all independent variables used. As mentioned, per capita total expenditure levels are used as the main indicator of living standard. Educational levels are measured in terms of five categories, from zero indicating no education, to 4 indicating completed university education. More than half of the male and female individuals still live in rural areas, around 80% are married, and the mean age is about 41 years. As can also be seen, smoking is a common habit among male adults in Indonesia, but not among females.

The regression results are shown in Table 8. Columns (1) and (2) simply regress the BMI of male and female adults on a set of socioeconomic variables, like living standard, education, and location. This is the standard approach in the literature. However, in our conceptual framework we identified these socioeconomic variables as indirect influencing factors. Therefore, in a second set of regressions in columns (3) and (4), we only include our proxies for the direct influencing factors, food consumption and physical activity, as explanatory variables. And finally, in a third set of regressions in columns (5) and (6) we include both direct and indirect influencing factors. All regressions also include province dummies to control for unobserved regional heterogeneity, such as climate and ethnicity. For space reasons, results for these province dummies are not shown in Table 8.

The results in columns (1) and (2) are as expected for this standard regression model. Higher living standards contribute to higher BMI. An increase in per capita expenditure by 100 thousand rupiah (about 20% of the mean expenditure level) increases the BMI among males by 0.1. While this effect is highly significant, it is not very large. The expenditure effect is even smaller among women, suggesting that there must be other important variables influencing nutritional outcomes. Education has a relatively strong positive effect among males, but not among females. Education is expected to increase nutritional awareness and health knowledge, which should contribute to higher BMI for those at risk of underweight and lower BMI for those at risk of overweight. On the other hand, education is also associated with the type of occupation, with higher educational levels increasing the probability of being employed in sedentary office positions. The latter is less relevant for women in Indonesia, because the majority of them are not employed but busy with housekeeping. This could explain the insignificance of the effect for women. However, since we do not control for physical activity levels in this first set of regressions, interpretation of the education coefficients remains somewhat ambiguous at this stage.

Age increases the BMI significantly, though at a decreasing rate at higher age levels, as indicated by the negative square term coefficients. This is as expected. Likewise, marriage has a large

positive effect, significantly increasing the risk of overweight and obesity especially for women. On average, being married increases the female BMI by 1.4, which is likely due to cultural factors and changing lifestyles after marriage. In contrast, smoking reduces the BMI significantly among both men and women, which can be explained by the increased body metabolism and reduced appetite among smokers. In terms of household location, people living in rural areas have a significantly lower BMI than people in urban areas; this effect is particularly strong among women. Different explanations are possible. Exposure to modern retail outlets and fast-food restaurants is usually lower in rural areas, which may affect dietary patterns. Moreover, the types of jobs available in rural areas often require higher physical activity levels. And finally, rural infrastructure constraints may also contribute to higher activity levels during household work and leisure time.

The difficulty to explain the exact mechanisms behind some of the effects suggests that the next sets of regressions may offer interesting additional insights. In columns (3) and (4) of Table 8, where the direct influencing factors are included without the socioeconomic variables, most of the coefficients are significant and with the expected sign. With respect to food consumption, the level of per capita food expenditures significantly increases the BMI, which is plausible. However, the effect is relatively small in magnitude, which may partly be related to the fact that food expenditures are an imprecise measure of food quantity consumed. The meat and dairy expenditure share also increases the BMI, although the coefficient is not significant for women. For men, an increase in the meat and dairy share of 0.1 (10 percentage points) increases the BMI by 0.12 on average. In contrast, the staple food share has a relatively strong negative effect on BMI for both men and women. These results confirm our expectations and suggest that both food quantity and changes in dietary composition as part of the nutrition transition contribute to overweight and obesity in Indonesia.

Results for the physical activity proxies are also in line with expectations. Lighter physical activity levels during work contribute to higher BMI. Working in a sedentary job, as compared to a job involving heavy physical work, increases the BMI by 1.0 for women and by almost 2.0 for men. Similarly, housekeeping, again compared with jobs involving heavy physical activity, contributes to a higher BMI, albeit this effect is only significant for women. This is in contrast to results from some developed countries, where work-related physical activity is not always associated with BMI and obesity (e.g., Gutierrez-Fisac et al., 2002). We also find that physical activity in leisure time has an important effect on BMI. Owning a television is associated with a 0.7 and 1.1 higher BMI for men and women, respectively, suggesting indeed that watching television prevents people from more active hobbies. Furthermore, television may influence food consumption behavior through parallel intake of junk food and through commercial advertisements. Estimation coefficients for the value of household appliances are positive and significant, too, suggesting that these appliances ease physical activity during household work. The last set of regressions in Table 8, shown in columns (5) and (6), combine direct and indirect factors as explanatory variables of BMI. The effects of all socioeconomic variables are significant, which is also the reason why these variables could not be used as instruments

for food consumption and physical activity in a two-stage regression approach. There are two possible reasons for this phenomenon. First, the socioeconomic factors may also have direct effects on BMI that are not channeled through either food consumption or physical activity. Second, and perhaps more likely, our proxies capture food consumption and physical activity only partially, so that the availability of more specific data might change the results.

Nonetheless, it is worth mentioning that the magnitude of some of the effects of socioeconomic variables changes in columns (5) and (6), as compared to columns (1) and (2), which is due to the expected correlation between direct and indirect influencing factors. For instance, the positive education effect is now considerably smaller for men, and it even turns negative and significant for women. This indicates that better educated women have a lower BMI than their uneducated counterparts. Given the high observed prevalence rates of overweight and obesity among women, this negative net education effect is not surprising. Also for the direct determinants, some of the coefficients change comparing columns (5) and (6) with columns (3) and (4). Strikingly, per capita food expenditures now have a small negative effect, which is counterintuitive. However, food expenditures are closely correlated with total per capita expenditures. Furthermore, as explained above, food expenditures are an imperfect measure of food and calorie quantity consumed, as quality aspects are hardly controlled for. Yet the food composition proxies keep their signs and significance levels, as do our proxies for work and leisure-related physical activity.

4.2 CHANGE REGRESSIONS

To analyze dynamic aspects and better exploit the panel structure of the data, we now use a somewhat different regression approach with the change in individual BMI between 2000 and 2007 as dependent variable. This is only possible for individuals that were included in these two survey waves, so that the sample is smaller than in the preceding cross-section analysis. However, with around 5500 adult males and 7000 adult females the number of observations is still sufficient for robust estimates. As explanatory variables we use the same direct and indirect factors discussed before, but now every variable is represented twice; first as a level variable measuring the value in the base year 2000, and second as a change variable indicating the change between 2000 and 2007. Monetary expenditure values were adjusted using the consumer price index. While the change for continuous variables is straightforward to calculate, the change for dummy variables is represented as +1 when an individual moved into a certain category and as –1 if an individual moved out of the respective category. In addition, we include base year dummies for the BMI categories underweight, preobese, and obese, using normal weight as the reference.

The estimation results for these change regressions are shown in Table 9. Overall, they confirm and strengthen the findings so far. For many of the socioeconomic variables, the base year and change coefficients are significant. The same holds true for the work-related physical activity levels, and also for possession of a television. These patterns suggest that BMI levels will further

increase in Indonesia with rising living standards and a continuing trend towards more sedentary lifestyles. As mentioned above, work-related physical activity was not always found to influence BMI in developed countries, so that this may be a specific result for developing countries with high economic growth rates and where widespread and dramatic changes in the type of employment occur within a relatively short period of time. Results by Bell et al. (2001) in China point into the same direction.

Striking in Table 9 are also the base year coefficients for the BMI categories, which are all positive and highly significant. For individuals who were underweight in 2000, this is good news; many of them improved their nutritional status within a relatively short period of time. The results for the other two categories are worrisome, however, as they indicate that individuals who were already preobese or obese in 2000, increased their BMI much more than individuals who started with a normal weight. This is in line with the above analysis of changes in BMI distribution and indicates considerable path-dependencies. It clearly suggests that the obesity pandemic in Indonesia will increase in extent and severity, unless significant remedial action is taken.

Somewhat surprising and disappointing are the results for the food consumption variables, most of which are not significant in Table 9. We attribute this to measurement problems; aggregated food expenditure data seem to be relatively weak proxies of individual calorie intake and dietary composition. This may be true in particular when comparing different time periods, where changes in quality preferences and price levels are likely to occur but cannot be properly controlled for. To fully understand changes in food preferences and dietary patterns and to analyze their impact on BMI in the nutrition transition, better and more disaggregated food consumption data are definitely needed. Especially processed food items and meals taken away from home are often poorly captured in living standard surveys, which holds true not only for Indonesia but for developing countries more generally.

5 Conclusion

We have analyzed patterns, trends, and determinants of overweight and obesity among adults in Indonesia, using detailed household and individual level data spanning the time period from 1993 to 2007. The descriptive analysis confirms that Indonesia is in the process of a fast and profound nutrition transition, with constantly rising prevalence rates of obesity. While the BMI of individuals is positively associated with living standard, this trend is not confined to the richer segments of the population. Many in the poorer income quintiles have also increased their BMI beyond normal weight levels over the 14-year period of observation. Also, unlike often assumed, the nutrition transition is not confined to urban areas, but affects rural settings as well, and at accelerating rates. A gender disaggregation has revealed that both men and women have increased their BMI substantially on average. Nonetheless, the problem is much more pronounced among the female population. In 2007,

50% of adult women in Indonesia were overweight; 20% were classified as obese. At the same time, 12% of the adult population is underweight. Clearly, Indonesia is facing a dual burden of malnutrition.

The fact that women in Indonesia are significantly more affected by overweight and obesity than men is likely due to cultural and religious reasons. In traditional Muslim societies in Asia, women are often less free to work outside home, especially when they are married. This pattern does not seem to change much with rising living standards. On the contrary, when the economic need for a second salary decreases, women may become even more confined. The same holds true for sports and other physical exercises, which are rather uncommon leisure activities for women in Indonesia. Exceptions are very well educated women in households at the upper end of the income distribution, whose lifestyles are more influenced by western culture.

We also developed a conceptual framework, distinguishing between direct and indirect determinants of obesity, which we then used for regression analysis. This differentiation has rarely been made in previous studies, but it helps to better understand the underlying mechanisms and is of particular importance for policy making purposes. Cross-section regression results confirm that direct influencing factors, including food consumption and physical activity during work and leisure time, determine nutritional outcomes to a significant extent. In terms of food, higher overall consumption levels, a higher share of meat and dairy products, and a lower share of traditional staple foods lead to a higher BMI. These are typical directions of consumption changes in the context of the nutrition transition. Unfortunately, the relatively aggregate food expenditure data available in the survey did not allow a more detailed analysis of sugar and fat contents or other aspects of dietary composition and quality, which would have been interesting to better understand preference shifts and their nutritional implications.

In terms of work-related physical activity, more sedentary jobs cause a significant increase in BMI for both men and women. This is a typical trend in economically fast growing developing countries like Indonesia, where more and more people move from jobs in agriculture or industry to office jobs in the service sector. Likewise, physical activity levels for household work and during leisure time decrease, also causing the BMI to rise. These effects remain significant in the regression models, even when additionally controlling for indirect socioeconomic variables such as income, education, marital status, and geographical setting. This underlines the particular importance of work and leisure-related physical activity in the nutrition transition in developing countries.

In another regression approach, we analyzed determinants of change in individual BMI over time. These additional models further strengthened the results. Strikingly, individuals who are already preobese or obese at a certain starting point, tend to increase their BMI much more over time than individuals who start from a normal weight. This indicates considerable path-dependencies and clearly suggests that the obesity pandemic in Indonesia will further increase in extent and severity, unless significant remedial action is taken. As is well known, this will entail a sizeable health burden

in terms of various chronic diseases. Compared to Indonesia, several other Muslim countries in Asia are still at an earlier stage of economic development, but the trends analyzed here may potentially also predict developments elsewhere – at least to some extent.

With respect to policy strategies, both food consumption trends and physical activity levels could potentially be influenced, although this will not be easy and requires behavioral change. Food and supply chain regulations, including food labels as well as taxes and subsidies to set incentives towards more healthy foods, are one possible avenue. Yet, experience from developed countries suggests that such policies may be difficult to implement and may also not be sufficiently effective. A more promising approach would be broad-based educational campaigns towards more balanced diets and physical exercise, also clearly explaining the health risks associated with excess weight. Such campaigns need to have a long-term perspective, and they should already start in primary school. For obvious reasons, women should be targeted in particular, although cultural change certainly also requires the involvement of men. Work-related physical activity will be difficult to influence through policy, because the trend towards more sedentary jobs is intrinsically linked with economic development. But the choice of transportation and leisure time activities may be influenced through educational and awareness campaigns in the longer run.

There are also a few research implications emerging from our results. Cultural factors were not properly captured here, but they may be important to better understand nutritional trends and outcomes. Furthermore, the food expenditure data used are only imperfect proxies of food consumption and dietary composition. This is a general problem in living standard survey data from developing countries. In order to really understand food preference changes in the nutrition transition, better and more disaggregated food consumption data are needed, including many more details on processed food items and meals eaten away from home. Databases and survey formats should be better adapted to changing situations and emerging problems and research directions.

References

Abdulai, A., 2010. Socio-economic characteristics and obesity in underdeveloped economies: does income really matter? Applied Economics 42, 157-169.

Adams, E.J., Grummer-Strawn, L., Chavez, G., 2003. Food insecurity is associated with increased risk of obesity in California women. The Journal of Nutrition 133, 1070-1074.

Albala, C., Vio, F., Kain, J., Uauy, R., 2002. Nutrition transition in Chile: determinants and consequences. Public Health Nutrition 5, 123-128.

Asfaw, A., 2007. Do government food price policies affect the prevalence of obesity? Empirical evidence from Egypt. World Development 35, 687-701.

Bell, A.C., Ge, K., Popkin, B.M., 2001. Weight gain and its predictors in Chinese adults. International Journal of Obesity 25, 1079-1086.

Caputo, A., Foraita, R., Klasen, S., Pigeot, I., 2003. Undernutrition in Benin--an analysis based on graphical models. Social Science & Medicine 56, 1677-1691.

Case, A., Menendez, A., 2009. Sex differences in obesity rates in poor countries: Evidence from South Africa. Economics & Human Biology 7, 271-282.

Elia, M., 2001. Obesity in the elderly. Obesity Research 9, 244s-248s.

Fernald, L.C.H., 2007. Socio-economic status and body mass index in low-income Mexican adults. Social Science & Medicine 64, 2030-2042.

Frankenberg, E., Karoly, L., 1995. The 1993 Indonesian Family Life Survey: Overview and Field Report. RAND, Santa Monica, CA.

Gaiha, R., Jha, R., Kulkarni, V.S., 2010. Obesity, affluence and urbanisation in India, in: University, A.N. (Ed.), ASARC Working Papers. Australia South Asia Research Centre.

Gurrici, S., Hartriyanti, Y., Hautvast, J.G., Deurenberg, P., 1998. Relationship between body fat and body mass index: differences between Indonesians and Dutch Caucasians. European Journal of Clinical Nutrition 52, 779-783.

Hansford, F., 2010. The nutrition transition: a gender perspective with reference to Brazil. Gender and Development 18, 439-452.

Huffman, S.K., Rizov, M., 2010. The rise of obesity in transition: theory and empirical evidence from Russia. Journal of Development Studies 46, 574-594.

Kaiser, L.L., Townsend, M.S., Melgar-Quinonez, H.R., Fujii, M.L., Crawford, P.B., 2004. Choice of instrument influences relations between food insecurity and obesity in Latino women. The American Journal of Clinical Nutrition 80, 1372-1378.

Lakdawalla, D., Philipson, T., 2009. The growth of obesity and technological change. Economics & Human Biology 7, 283-293.

Lipoeto, N.I., Wattanapenpaiboon, N., Malik, A., Wahlqvist, M.L., 2004. The nutrition transition in West Sumatra, Indonesia. Asian Pacific Journal of Clinical Nutrition 13, 312-316.

Lu, Y., Goldman, D., 2010. The effects of relative food prices on obesity: evidence from China: 1991-2006, NBER Working Papers.

Ma, B., 2010. Socioeconomic status and overweight and obesity: how does the gradient change with age? New evidence from China, UMBC Economics Department Working Papers. UMBC Department of Economics.

Martorell, R., Khan, L.K., Hughes, M.L., Grummer-Strawn, L.M., 2000. Obesity in women from developing countries. European Journal of Clinical Nutrition 54, 247-252.

Mokhtar, N., Elati, J., Chabir, R., Bour, A., Elkari, K., Schlossman, N.P., Caballero, B., Aguenaou, H., 2001. Diet culture and obesity in Northern Africa. Journal of Nutrition 131, 887s-892s.

Monteiro, C.A., Moura, E.C., Conde, W.L., Popkin, B.M., 2004. Socioeconomic status and obesity in adult populations of developing countries: a review. Bulletin of the World Health Organization 82, 940-946.

Norman, A., Moradi, T., Gridley, G., Dosemeci, M., Rydh, B., Nyren, O., Wolk, A., 2002. Occupational physical activity and risk for prostate cancer in a nationwide cohort study in Sweden. British Journal of Cancer 86, 70-75.

Offer, A., Pechey, R., Ulijaszek, S., 2010. Obesity under affluence varies by welfare regimes The effect of fast food, insecurity, and inequality. Economics & Human Biology 8, 297-308.

Paeratakul, S., Adair, L.S., Zhai, F., Ge, K., Popkin, B.M., 1999. Sex difference in measures of body fatness and the possible difference in the effect of dietary fat on body fatness in men and women. European Journal of Clinical Nutrition 53, 865-871.

Paeratakul, S., Popkin, B.M., Keyou, G., Adair, L.S., Stevens, J., 1998. Changes in diet and physical activity affect the body mass index of Chinese adults. International Journal of Obesity 22, 424-431.

Philipson, T., 2001. The world-wide growth in obesity: an economic research agenda. Health Economics 10, 1-7.

Popkin, B.M., 1999. Urbanization, lifestyle changes and the nutrition transition. World Development 27, 1905-1916.

Popkin, B.M., 2001. The nutrition transition and obesity in the developing world. Journal of Nutrition 131, 871s-873s.

Popkin, B.M., 2004. The nutrition transition: An overview of world patterns of change. Nutrition Reviews 62, S140-S143.

Popkin, B.M., Gordon-Larsen, P., 2004. The nutrition transition: worldwide obesity dynamics and their determinants. International Journal of Obesity 28, S2-S9.

Popkin, B.M., Richards, M.K., Monteiro, C.A., 1996. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. Journal of Nutrition 126, 3009-3016.

Rosin, O., 2008. The economic causes of obesity: a survey. Journal of Economic Surveys 22, 617-647.

Shetty, P.S., 2002. Nutrition transition in India. Public Health Nutrition 5, 175-182.

Smith, L.C., Haddad, L.J., 2000. Explaining child malnutrition in developing countries: a cross-country analysis, Research reports. International Food Policy Research Institute (IFPRI), Washington D.C.

Speakman, J.R., Westerterp, K.R., 2010. Associations between energy demands, physical activity, and body composition in adult humans between 18 and 96 y of age. American Journal of Clinical Nutrition 92, 826-834.

Strauss, J., Beegle, K., Sikoki, B., Dwiyanto, A., Herawati, Y., Witoelar, F., 2004. The third wave of the Indonesia Family Life Survey (IFLS): overview and field report, WR-144/1-NIA/NICHD.

Strauss, J., Witoelar, F., Sikoki, B., Wattie, A.M., 2009. The fourth wave of the Indonesian Family Life Survey (IFLS4): overview and field report, WR-675/1-NIA/NICHD.

Subramanian, S.V., Davey-Smith, G., 2006. Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. American Journal of Clinical Nutrition 84, 633-640.

Subramanian, S.V., Perkins, J.M., Özaltin, E., Davey-Smith, G., 2011. Weight of nations: a socioeconomic analysis of women in low- to middle-income countries. The American Journal of Clinical Nutrition 93, 413-421.

Uauy, R., Albala, C., Kain, J., 2001. Obesity trends in Latin America: Transiting from under- to overweight. Journal of Nutrition 131, 893s-899s.

Usfar, A.A., Lebenthal, E., Atmarita, Achadi, E., Soekirman, Hadi, H., 2010. Obesity as a poverty-related emerging nutrition problems: the case of Indonesia. Obesity Reviews 11, 924-928.

Valeggia, C.R., Burke, K.M., Fernandez-Duque, E., 2010. Nutritional status and socioeconomic change among Toba and Wichí populations of the Argentinean Chaco. Economics & Human Biology 8, 100-110.

Vio, F., Albala, C., Kain, J., 2008. Nutrition transition in Chile revisited: mid-term evaluation of obesity goals for the period 2000-2010. Public Health Nutrition 11, 405-412.

WHO, 2004. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 363, 157-163.

World Bank, 2007. Horticultural producers and supermarket development in Indonesia. The World Bank, Washington D.C.

Figures

Figure 1 Conceptual framework of determinants of nutritional status

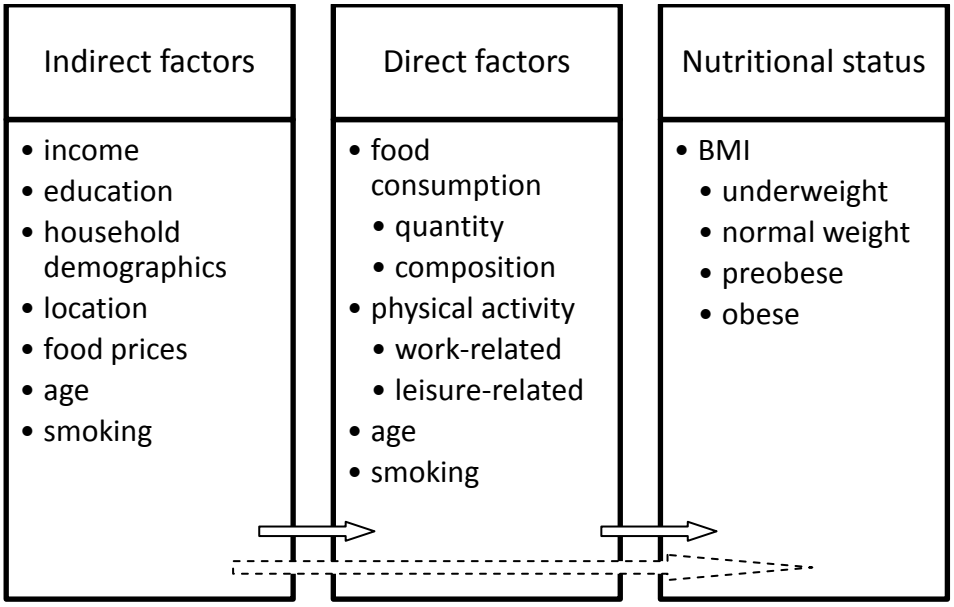
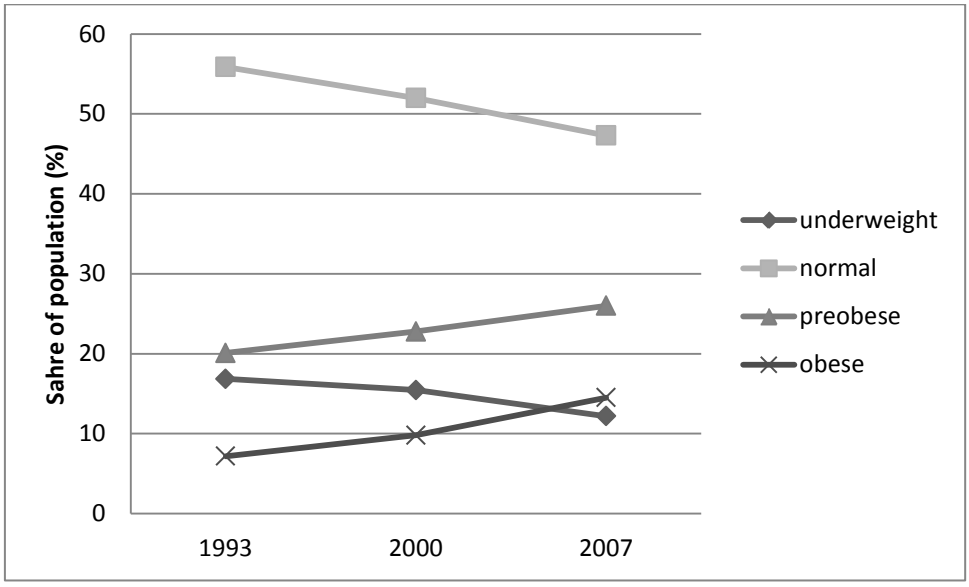
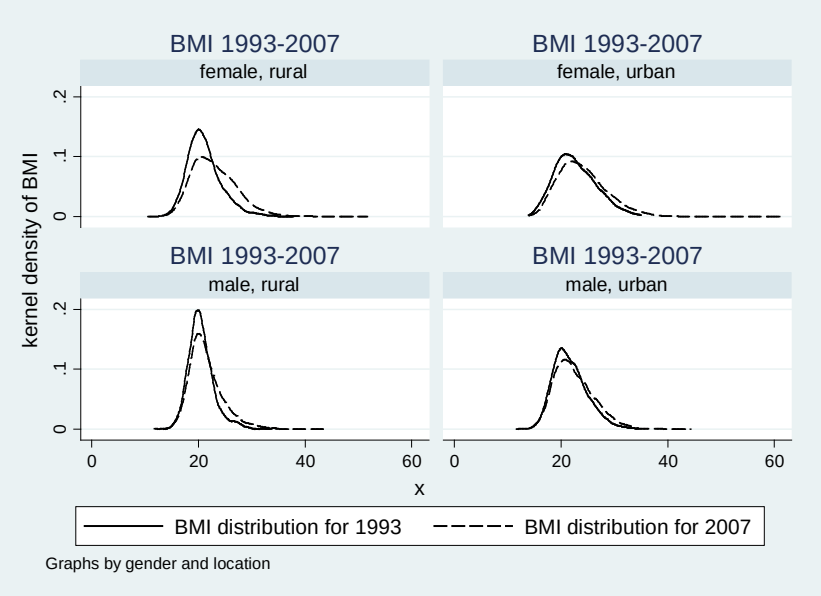


Figure 2 Share of population in BMI categories over time



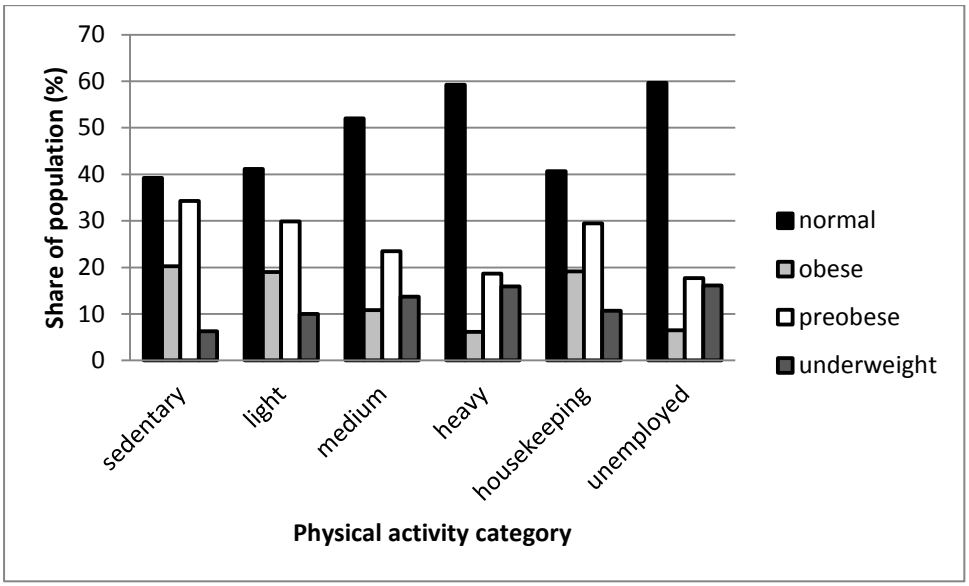
Source: IFLS1, IFLS3, IFLS4

Figure 3 BMI density curves in 1993 and 2007



Source: IFLS 1 & IFLS 4

Figure 4 Work-related physical activity and BMI category (2007)



Source: IFLS4

Tables

Table 1 Sample size of male and female individuals (20 to 75 years of age)

	Total	Female		Male		Rural		Urban	
Year		**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**
1993	10,915	6,164	56.47	4,751	43.53	5,915	54.2	4,999	45.8
2000	17,495	9,190	52.53	8,305	47.47	9,948	56.86	7,546	43.14
2007	22,160	11,718	52.88	10,442	47.12	12,343	55.7	9,816	44.3

Source: IFLS1, IFLS3 and IFLS4

Table 2 BMI by gender and location

	Male				Female			
	Urban		Rural		Urban		Rural	
Year	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1993	21.74	3.18	20.49	2.47	22.73	3.90	21.09	3.20
2000	21.96	3.45	20.83	2.78	23.34	4.25	21.86	3.73
2007	22.50	3.71	21.38	3.16	24.03	4.52	22.97	4.23

Source: IFLS1, IFLS3, IFLS4

Table 3 Share of individuals in BMI categories (%)

	1993		2000		2007	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Underweight	16.82	16.89	16.52	14.47	13.66	10.87
Normal weight	62.39	50.83	58.61	45.98	55.2	40.26
Preobese	16.76	22.66	18.9	26.27	22.33	29.27
Obese	4.02	9.62	5.96	13.28	8.81	19.6
Total	100	100	100	100	100	100

Source: IFLS1, IFLS3, IFLS4

Table 4 Mean change in BMI by gender and location

		1993-2000	2000-2007
Male	**urban**	0.57	1.08
	rural	0.18	0.64
Female	**urban**	1.18	1.27
	rural	0.78	1.11

Table 5 Food expenditures by nutritional status for 2007

	Non-overweight			Overweight			
Variable	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Diff. in means**
Total food expenditures (in Indonesian rupiah)	13082	211780	178179	9078	246328	202977	***
Meat and dairy share	13082	0.149	0.108	9078	0.171	0.113	***
Staple food share	13082	0.237	0.153	9078	0.204	0.143	***
Household appliances (in Indonesian rupiah)	13082	1833187	3267652	9078	3080198	10200000	***
Television	13082	0.737	0.441	9078	0.852	0.355	***

Source: IFLS4
Note: *** significant difference between overweight and non-overweight individuals at the 1% level.

Table 6 Correlation coefficients for 2007

Male	BMI	Exp p.c.	Food exp p.c.	Meat and dairy share	Staple food share	Household appliances
BMI	1					
Exp p.c.	0.2046	1				
Food exp p.c.	0.1213	0.8063	1			
Meat and dairy share	0.1351	0.1018	0.0631	1		
Staple food share	-0.1505	-0.3559	-0.3146	-0.3076	1	
Household appliances	0.1258	0.2272	0.1397	0.1112	-0.1280	1
Television	0.1578	0.1347	0.0524	0.1883	-0.1577	0.1298
Female						
BMI	1					
Exp p.c.	0.1157	1				
Food exp p.c.	0.0784	0.7828	1			
Meat and dairy share	0.0713	0.1872	0.1809	1		
Staple food share	-0.1012	-0.2951	-0.2462	-0.3581	1	
Household appliances	0.0719	0.2230	0.1475	0.1140	-0.1312	1
Television	0.1519	0.1630	0.0937	0.1794	-0.2172	0.1190

Note: All correlation coefficients shown are significant at the 1% level.

Table 7 Descriptive statistics of sample used for OLS regressions (2007)

	Male (n=10175)		Female (n=11985)	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Body mass index (BMI)	21.87	3.45	23.45	4.40
Expenditures p.c. (100 thsd. rupiah)	5.22	4.68	5.25	5.13
Education (0-4)	1.97	1.12	1.71	1.14
Rural location (dummy)	0.56	0.50	0.55	0.50
Married (dummy)	0.83	0.37	0.79	0.41
Age (years)	41.00	13.27	40.83	13.39
Smoking (dummy)	0.71	0.45	0.02	0.14
Food consumption				
Food exp p.c. (100 thsd. rupiah)	2.75	2.26	2.69	2.30
Meat and dairy share	0.15	0.11	0.16	0.11
Staple food share	0.22	0.15	0.23	0.15
Work-related physical activity				
Sedentary work (dummy)	0.04	0.21	0.02	0.15
Light work (dummy)	0.29	0.45	0.25	0.43
Medium work (dummy)	0.25	0.43	0.06	0.24
Heavy work (dummy)	0.35	0.48	0.15	0.36
Housekeeping (dummy)	0.04	0.19	0.51	0.50
Unemployed (dummy)	0.03	0.16	0.00	0.05
Leisure-related physical activity				
Possession of television (dummy)	0.79	0.41	0.78	0.41
Household appliances (100 thsd. rupiah)	23.12	65.52	23.62	73.79

Source: IFLS4

Table 8 OLS regressions with BMI as dependent variable (2007)

Variables	(1) Male	(2) Female	(3) Male	(4) Female	(5) Male	(6) Female
Constant	17.24***	17.45***	17.30***	16.23***	17.01***	16.14***
	(57.04)	(46.13)	(54.02)	(39.96)	(51.09)	(37.51)
Expenditures per capita	0.1000***	0.0735***			0.110***	0.0621***
	(9.520)	(6.672)			(5.464)	(4.274)
Education	0.455***	0.0808			0.256***	-0.0954*
	(12.08)	(1.348)			(6.363)	(-1.667)
Age	0.160***	0.220***	0.183***	0.242***	0.151***	0.212***
	(11.36)	(14.55)	(13.53)	(15.80)	(11.19)	(14.39)
Age squared	-0.00172***	-0.00230***	-0.00193***	-0.00260***	-0.00161***	-0.00220***
	(-11.61)	(-13.47)	(-13.28)	(-15.43)	(-11.30)	(-13.29)
Rural location	-0.527***	-0.826***			-0.249***	-0.479***
	(-5.578)	(-5.202)			(-2.584)	(-3.199)
Married	1.059***	1.410***			0.923***	1.351***
	(11.22)	(12.08)			(9.472)	(11.68)
Smoking	-0.983***	-0.969***	-1.006***	-0.840***	-0.903***	-0.840***
	(-12.28)	(-3.038)	(-12.65)	(-2.650)	(-11.44)	(-2.755)
Food consumption						
Food exp p.c.			0.0865***	0.0622**	-0.0822**	-0.0291
			(4.719)	(2.439)	(-2.482)	(-0.855)
Meat and dairy share			1.240***	0.550	0.839**	0.595
			(3.170)	(1.136)	(2.168)	(1.235)
Staple food share			-1.415***	-1.120***	-0.822***	-0.856**
			(-4.967)	(-3.093)	(-2.920)	(-2.455)
Work-related physical activity						
Sedentary work			1.952***	1.018***	1.343***	1.030***
			(9.156)	(3.151)	(6.366)	(3.127)
Light work			1.173***	1.623***	0.865***	1.611***
			(10.28)	(10.98)	(7.713)	(11.05)
Medium work			0.638***	0.575***	0.458***	0.593***
			(5.946)	(2.585)	(4.339)	(2.694)
Housekeeping			0.282	1.209***	0.174	1.067***
			(1.599)	(8.948)	(0.988)	(8.220)
Unemployed			0.556**	-1.133*	0.605**	-0.332
			(2.271)	(-1.813)	(2.532)	(-0.516)
Leisure-related physical activity						
Possession of television			0.654***	1.101***	0.461***	0.952***
			(7.655)	(9.877)	(5.699)	(8.687)
Household appliances			0.00321*	0.00189**	0.00199*	0.00140***
			(1.809)	(2.172)	(1.928)	(2.680)
Observations	10175	11985	10175	11985	10175	11985
R-squared	0.138	0.076	0.135	0.083	0.157	0.100

Notes: Robust t-statistics in parentheses. ***, **, and * means significant at the 1%, 5%, and 10% level, respectively. Heavy physical work is the omitted reference for work-related physical activity. Province dummies were included in estimation but are not shown for space reasons.

Table 9 Determinants of change in BMI from 2000 to 2007

	(1) Male		(2) Female	
	Coefficients	**t-statistics**	**Coefficients**	**t-statistics**
Constant	0.625**	2.033	1.354***	4.339
Expenditure per capita (base year)	0.0415**	2.482	0.0169	1.243
Expenditure per capita (change)	0.0404***	2.796	0.0209*	1.770
Education (base year)	0.0980***	3.022	-0.000673	-0.0177
Education (change)	0.116	1.360	-0.0982	-0.911
Age (base year)	-0.0351***	-3.480	-0.0615***	-6.491
Age squared (base year)	4.51e-05	0.383	0.000120	1.084
Rural location (base year)	-0.0735	-1.055	0.0455	0.594
Rural location (change)	0.0547	0.570	0.0560	0.530
Married (base year)	0.129	1.108	0.331***	3.603
Married (change)	0.371***	3.061	0.519***	5.367
Smoking (base year)	-0.313***	-4.723	-0.538**	-2.434
Smoking (change)	-0.381***	-4.713	-0.00294	-0.013
BMI category (base year)				
Underweight	0.935***	7.726	0.881***	9.267
Preobese	0.710***	5.545	0.687***	6.883
Obese	1.121***	8.262	1.160***	9.717
Food consumption				
Food expenditure p.c. (base year)	-0.0221	-0.689	-0.0468	-1.455
Food expenditure p.c.(change)	0.0153	0.562	-0.0214	-0.864
Meat and dairy share (base year)	-0.536	-1.491	0.546	1.357
Meat and dairy share (change)	-0.459*	-1.660	0.108	0.356
Staple food share(base year)	-0.468*	-1.687	-0.258	-0.847
Staple food share (change)	-0.357*	-1.696	-0.320	-1.382
Work-related physical activity				
Sedentary work (base year)	0.481***	2.612	0.921***	2.923
Sedentary work (change)	0.310*	1.953	0.782***	3.008
Light work (base year)	0.515***	5.576	0.481***	3.985
Light work (change)	0.387***	4.625	0.434***	4.054
Medium work (base year)	0.293***	3.249	0.187	1.058
Medium work (change)	0.276***	3.324	0.159	1.052
Housekeeping (base year)	0.542*	1.714	0.322***	2.853
Housekeeping (change)	0.128	0.865	0.197**	2.193
Unemployed (base year)	-0.00211	-0.007	3.515**	2.322
Unemployed (change)	0.0902	0.376	2.544*	1.762
Leisure-related physical activity				
Possession of television (base year)	0.383***	4.509	0.428***	4.548
Possession of television (change)	0.355***	4.949	0.346***	4.298
Household appliances (base year)	0.00154	1.256	0.000744	0.591
Household appliances (change)	0.00138	1.304	0.00278**	2.432
Observations	5537		6913	
R-squared	0.114		0.118	

Notes: ***, **, and * means significant at the 1%, 5%, and 10% level, respectively. Province dummies were included in estimation but are not shown for space reasons. Monetary values were adjusted by consumer price index.

Appendix 1 BMI distribution by expenditure quintile, location, and gender (1993 and 2007)