Obesity Trends, Determinants and Policy Implications in Indonesia

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Abstract:

Obesity is becoming a serious issue in many developing countries, with negative implications for economic growth and human wellbeing. While previous micro level studies on obesity have mostly used cross-section data, we analyze trends and determinants with panel data from Indonesia. Over the past 20 years, obesity has increased remarkably in Indonesia across all population groups, including rural and low income strata. The problem is particularly severe among women. Panel regressions confirm that changing food consumption patterns, coupled with decreasing physical activity, directly contribute to this trend. From a policy perspective, nutrition awareness and education campaigns, combined with programs to support leisure time exercise especially for women, seem to be most promising to contain the obesity pandemic.

Keywords: Obesity, Overweight, Nutrition Transition, Body Mass Index, Food Consumption, Physical Activity, Panel Data, Asia, Indonesia

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 (e.g., Gerbens-Leenes, Nonhebel, & Krol, 2010; Jones-Smith, Gordon-Larsen, Siddiqi, & Popkin, 2011b; Popkin, 2010). A major difference is that in developing countries relatively little attention is paid by policymakers to the problem of excessive weight gain; it is often 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), its spread hampers human welfare and economic development (Pinstrup-Andersen, 2007). Developing countries that already have high obesity prevalence rates are mainly found in Latin America (Lobato, Costa, & Sichieri, 2009; Rivera, Barquera, González-Cossío, Olaiz, & Sepúlveda, 2004; Vio, Albala, & Kain, 2008), the Middle East, and North Africa (Mehio Sibai et al., 2010). But also in Asia and Sub-Saharan Africa, where undernutrition is still more prevalent, obesity is rising, causing a double burden of malnutrition. The emergence of this paradox is reinforced by the so-called nutrition transition. This term comprises food consumption and physical activity changes that are associated with lifestyle transformations in modernizing societies (Popkin, 2003). Whereas in developed countries this process occurred gradually, in many developing countries it proceeds at a much faster rate. Further, childhood stunting was found to be positively associated with adult obesity (e.g., Hoffman, Sawaya, Verreschi, Tucker, & Roberts, 2000; Olson, Bove, & Miller, 2007), making developing countries especially vulnerable. 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 (Chan & Sobal, 2011; Lakdawalla & Philipson, 2009; Offer, Pechey, & Ulijaszek, 2010; Penman & Johnson, 2006; Williams, Germov, & Young, 2011). These findings are also interesting for developing countries, but they cannot be extrapolated directly, because of very different framework

conditions. Several recent studies have also focused on developing countries. Jones-Smith et al. (2011b) and Subramanian, Perkins, Oezaltin, & Davey-Smith (2011) have used Demographic and Health Surveys of various low and middle income countries to analyze the relationship between socioeconomic status and weight change. While obesity prevalence rates increase with wealth and education in low income countries, poorer and less educated people are also increasingly affected. Another study by Case and Menendez (2009) examined the importance of gender aspects for obesity prevalence rates in South Africa. Asfaw (2007) and Asfaw (2008) looked at the role of food prices and location of food purchases for obesity and dietary practices in Egypt and Guatemala, respectively.

One problem with existing obesity research in developing countries is that most studies build on cross-section data, such that trends and nutritional shifts over time have rarely been analyzed. A second problem is the main focus on wealth and education, especially in those studies that build on large and representative data sets. While wealth and education are certainly important, there may be additional determinants, such as food consumption choices, physical activity, or related behavioral variables. When such additional determinants are correlated with wealth or education, omitting them in regression models may lead to biased results and conclusions. Unfortunately, representative surveys that contain anthropometric data needed for obesity analysis do usually not provide sufficient details on food consumption, physical activity levels, and other socioeconomic factors (de Haen, Klasen, & Qaim, 2011). Notable exceptions for both problems include several studies for China, where the China Health and Nutrition Surveys provide a useful data base for analyzing obesity dynamics and behavioral determinants (Jones-Smith, Gordon-Larsen, Siddiqi, & Popkin, 2011a; Ng, Norton, Guilkey, & Popkin, 2010; Ng, Norton, & Popkin, 2009).

We contribute to the literature by analyzing obesity trends and determinants in Indonesia, where suitable panel data are available. Indonesia is an interesting case to study also for several other reasons. First, Indonesia is a large and populous country and one of the economically fast growing nations of Asia, so that significant nutritional dynamics can be expected. Recent research suggests that obesity rates are increasing in the country (Usfar et al., 2010). Lipoeto (2004) revealed a notable shift in causes of death

from infections to cardiovascular diseases. Second, rapid urbanization and a transformation of traditional food systems towards modern supply chains can be observed in Indonesia (World Bank, 2007). Third, unlike China and a few other countries, for which more research is already available, Indonesia is a country with a high share of Muslim population. This may play a role for the direction of lifestyle changes, especially when considering gender differences. Thus, Indonesia may offer interesting insights into developments that are likely to occur also in several other Muslim-dominated Asian countries that are still at earlier stages of economic development.

The rest of this article is structured as follows. The next section discusses the data from Indonesia and the analytical approach. Then, we present descriptive results, focusing on obesity trends in male and female adults. Subsequently, we estimate panel regression models to analyze obesity determinants. The last section concludes.

Methods

Data

Our analysis builds on data from the Indonesian Family and Life Survey (IFLS) of the RAND Corporation, an international public policy research institute headquartered in the USA. 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 then, 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 following four provinces: Bali, West Nusa Tenggara, South Kalimantan, and South Sulawesi. The choice of provinces was influenced by cost considerations for implementing the surveys, yet without compromising coverage of socioeconomic and ethnic diversity (Strauss, Witoelar, Sikoki, & Wattie, 2009). Within the selected provinces, villages

and households were sampled building on the National Socioeconomic Survey (SUSENAS) sampling frame of the Indonesian Bureau of Statistics (BPS). The data are representative at province level. For more detailed information on the sampling frame, see Frankenberg and Karoly (1995), Strauss et al. (2004), and Strauss, Witoelar, Sikoki, & Wattie (2009). The survey includes data on health, anthropometric measurements of adults and children, and detailed information on various socioeconomic characteristics, including household level assets and expenditures, and individual level employment.

The analysis here concentrates on male and female adults aged 20 to 75. We do not include children and adolescents, because nutritional determinants can be quite different for these age groups. For example, we look at work-related physical activity, which is not relevant for most children. Moreover, the body mass index (BMI), which is the most widely used indicator of nutritional status among adults, is less appropriate for children (WHO, 1995). 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 living standards harshly (e.g., Suryahadi, Sumarto, & Pritchett, 2003; Thomas & Frankenberg, 2007) and could thus lead to ambiguous results in the trend analysis. Second, focusing on 1993, 2000, and 2007 means having equal time intervals between the survey waves, which is advantageous when analyzing and interpreting nutritional dynamics.

The sample size has grown over time, because additional household members were born or interviewed, and split-off households were tracked in the survey (Table 1). The sample used for our analysis includes only individuals for whom complete data on all variables of interest are available.

Table 1 Sample size for adult individuals and percentages by gender and location (20 to 75 years of age)

Year	Total	Male %	Female %	Rural %	Urban %
1993	10,227	0.46	0.54	0.55	0.45
2000	17,041	0.49	0.51	0.52	0.48
2007	20,475	0.48	0.52	0.48	0.52

Source: IFLS1, IFLS3, IFLS4

Statistical Approach of Data Analysis

This study investigates nutritional status of Indonesian working age adults as well as trends and determinants with descriptive analysis and panel regression models. We consider food consumption, physical activity, and other socioeconomic variables to be the main influencing factors of nutritional outcome, measured in terms of the body mass index (BMI). Regression analysis may suffer from endogeneity bias, as nutritional outcomes and socioeconomic determinants might be jointly influenced by unobserved factors (Ng et al., 2010). Fixed effects models can control for unobserved heterogeneity, thus controlling for one possible cause of endogeneity (Baltagi, 2005). However, with fixed effects models one cannot efficiently estimate the influence of socioeconomic variables for which no or only very little variation is observed over time for individuals. Examples in our context include education, occupational characteristics, or household location. Hence we estimate both fixed and random effects models.

The variables employed in the analysis are explained below. For the regressions, we only use 2000 and 2007 data, because some explanatory variables of interest were not included in the 1993 survey. Sample mean values are shown in Table A1 in the Appendix. We estimate separate models for male and female adults, as the descriptive analysis suggests that gender differences in the estimation coefficients may be expected. Robust and cluster corrected standard errors at individual level are used to correct for possible heteroskedasticity and error correlation.

Body Mass Index (BMI)

The BMI – defined as the body weight in kilograms divided by the squared body height in meters – is used here as the indicator of adult 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 of adult nutritional status and the only one for which comparable data are usually available (WHO, 2000).

Part of the descriptive analysis requires classification of individuals by BMI categories. BMI categories and cut-off levels for undernourished, normal, and overweight individuals 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 are associated with lower BMI levels in Asians than in other populations (WHO, 2004). Gurrici, Hartriyanti, Hautvast, & Deurenberg (1998) calculated the cut-off value for obesity in Indonesian adult 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. For comparison, we additionally use the international BMI cut-off values of 25 for overweight and 30 for obesity.

Food Consumption Variables

Food consumption patterns influence nutritional outcomes, but they are often not included in obesity research building on secondary surveys due to data constraints. Aspects of both food quantity and diet composition are expected to play a role. 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 consumes meat, dairy products, and highly processed convenience and junk foods, replacing traditional foods with higher fiber contents (Hawkes, 2008; Popkin, 2003).

We proxy individual level food consumption with household per capita food expenditures. Unfortunately, physical quantities of food consumed are not available in IFLS. The surveys capture food expenditures 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 considered. To account for dietary composition, we also include the food expenditure share spent on meat and dairy products, expecting that a higher share is associated with higher BMI. Furthermore, we include the food expenditure share spent on traditional staple foods, such as 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 during the nutrition transition. Information about the sugar, fat, and salt content of foods and diets, which is expected to increase in the course of the nutrition transition, is not available in the dataset. Because Indonesia is characterized by a high share of Muslim population, alcohol consumption is very low and not considered in this analysis.

Physical Activity Variables

In addition to food consumption, physical activity during work and leisure time is expected to influence BMI. 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, Gordon-Larsen, Stevens, & Popkin, 2007; Ng et al., 2009). To proxy work-related activity, we use information about the occupation of individuals included in IFLS. The data contain 100 different occupation codes, which we categorize into four physical activity groups, building on a classification system used previously (Lu & 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 (Table A1).

Leisure-related physical activity includes household work and free time that can be used for hobbies and pleasure. 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. The value of such household appliances was captured in the survey and is used here as a proxy. Free time is sometimes used for sports and other

physical exercise. However, this is not yet very widespread in Indonesia, which is partly due to climatic and cultural factors. Instead, the popularity of watching television, playing videogames, and using the internet is increasing. Unfortunately, pleasure activities are not properly captured in the IFLS. We use a dummy that measures whether or not a household possesses a television as a proxy for free time activities. While this is an imperfect measure, ownership of a television increases the tendency towards more sedentary lifestyles and may reduce the time spent on more active hobbies (Du, Lu, Zhai, & Popkin, 2002). The variable is not used as a measure for household wealth or living standard, as nowadays television ownership is relatively widespread in Indonesia, and the correlation with income is relatively weak. Variables that capture living standard are described in the following.

Other Socioeconomic Variables

Income and socioeconomic status contribute to higher BMI in developing countries (Fernald, 2007; Jones-Smith et al., 2011b; Ma, 2010). This relationship may be multifaceted. Especially in countries with widespread undernutrition, higher incomes and better education are expected to contribute to more food consumption and higher dietary diversity. Furthermore, household living standard often influences physical activity levels. There may also be effects related to more frequent media use and other related factors. We use total expenditure levels per capita (for consumption of all food and non-food goods and services) as the main indicator of living standard. In addition, educational levels are measured in terms of four categories, from zero indicating no education, to 3 indicating completed university education. We also include a dummy for rural location. In spite of ongoing urbanization processes in Indonesia, about half of the population still lives in rural areas. Finally, dummies for marital status and smoking are considered in the regression analysis. Smoking increases body metabolism and reduces appetite (Chiolero, Faeh, Paccaud, & Cornuz, 2008). Summary statistics of all variables described are shown in Table A1.

Results

Descriptive Analysis

Table 2 BMI and change in BMI by gender and location

	Male				Female			
	Urban		Rural		Urban		Rural	
Year	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1993	21.80	3.21	20.48	2.48	22.77	3.92	21.05	3.21
2000	21.84	3.47	20.81	2.76	23.20	4.24	21.79	3.69
2007	22.48	3.75	21.43	3.20	23.90	4.49	22.89	4.18
Change 1993-2000	0.64		0.23		1.23		0.78	
Change 2000-2007	1.19		0.72		1.41		1.15	

Source: IFLS1, IFLS3, IFLS4
Note: Change signifies the average change in mean from 1993 to 2000 and from 2000 to 2007.

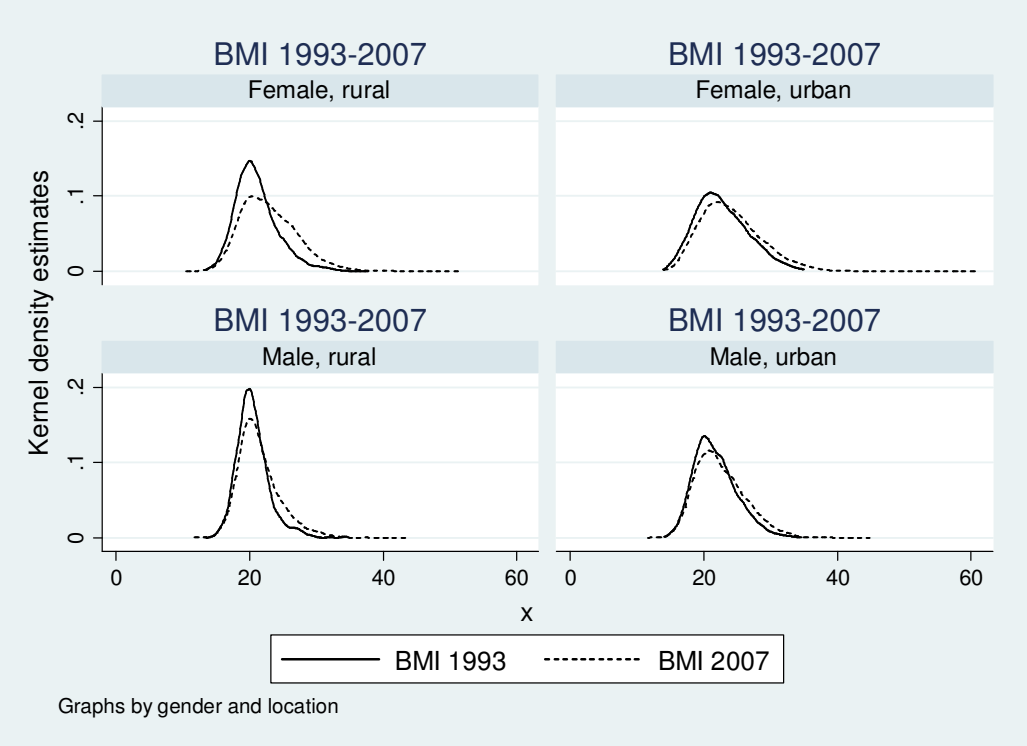
Mean BMI in Indonesian adults has increased notably since 1993 (Table 2). Women in Indonesia have a higher mean BMI than men, with the difference growing over time. This gender difference is more pronounced than in China. While rural men and women have a lower mean BMI, the increase over time is stronger 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.

The lower part of Table 2 shows how BMI of individuals has changed over time, namely from 1993 to 2000 and from 2000 to 2007. Mean change was positive in rural and urban areas and in both time periods. Furthermore, BMI change increased from the first to the second time period, suggesting that the nutrition transition in Indonesia has accelerated after 2000. The change was bigger for women than for men. Figure 1 visualizes the changes over time. It reveals that BMI distributions have become flatter between 1993 and 2007 for both men and women; that is, the population spread of BMI values has grown over time. In particular, the spread towards the right side of the distributions has increased, suggesting that individuals who started with higher BMI in 1993 increased their weight over-proportionally.

In urban areas, where the nutrition transition usually starts, the BMI distributions are much flatter than in rural areas (Figure 1). Also, they are 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 areas. In Figure A1 in the Appendix we show BMI distributions disaggregated by expenditure quintiles. The time trends discussed are clearly visible across all quintiles, underlining that also poorer population segments are increasingly affected by obesity.

Figure 2 (panel A, using Asian cut-off values for BMI) shows that the share of preobese and obese adults 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. When international BMI cut-off values are used (panel B of Figure 2), obesity prevalence rates are lower, as expected, but the time trend is similar. As mentioned above, international BMI cut-offs seem to underestimate obesity problems in Asian populations, so that use of the lower Asian cut-offs is more appropriate.

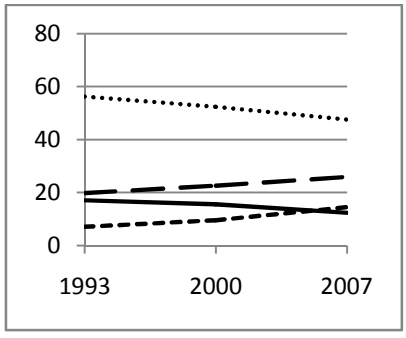
Figure 1 BMI density curves in 1993 and 2007



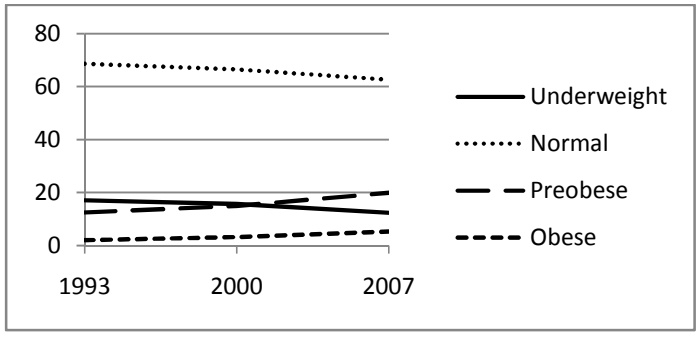
Source: IFLS 1, IFLS 4

Figure 2 Share of population in BMI categories over time (in %)

Panel A: Asian cut-off values



Panel B: International cut-off values



Source: IFLS1, IFLS3, IFLS4

Table 3 Share of individuals in BMI categories (%)

	1993		2000		2007	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Underweight	16.71	17.29	16.66	14.47	13.67	10.95
Normal weight	62.45	50.71	58.78	45.91	54.95	40.31
Preobese	16.79	22.33	18.73	26.4	22.48	29.11
Obese	4.05	9.67	5.83	13.22	8.9	19.64
Total	100	100	100	100	100	100

Source: IFLS1, IFLS3, IFLS4
Note: Asian cut-off values were used for BMI categories.

Table 3 provides a breakdown of the trends by gender. While the prevalence of underweight is similar for men and women, this is 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 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 and can partly be explained by biological factors. Women seem to have a higher propensity to store fat. Furthermore, after pregnancy women often have the problem of losing excess weight that they gained. But there are also cultural factors, related to the type of work and leisure activities acceptable for women in certain societies (Hansford, 2010). Especially in countries with a high Muslim population, women are sometimes less free to do sports and other physical exercises, which may raise the likelihood of accumulating excess weight. As women are often responsible for food choices and allocation in the household, higher female obesity prevalence rates may also increase the risk of children becoming overweight.

We now turn to the association between BMI and behavioral variables. Table 4 compares food expenditures for overweight and non-overweight individuals. Total food expenditures are significantly higher for the overweight population. Likewise, the meat and dairy expenditure share is significantly higher for overweight people, while the share spent on traditional staple foods is significantly lower. These patterns are as expected; they indicate that BMI is closely correlated with changing diets in the nutrition transition. The lower part of Table 4 also confirms that the value of household appliances (e.g.,

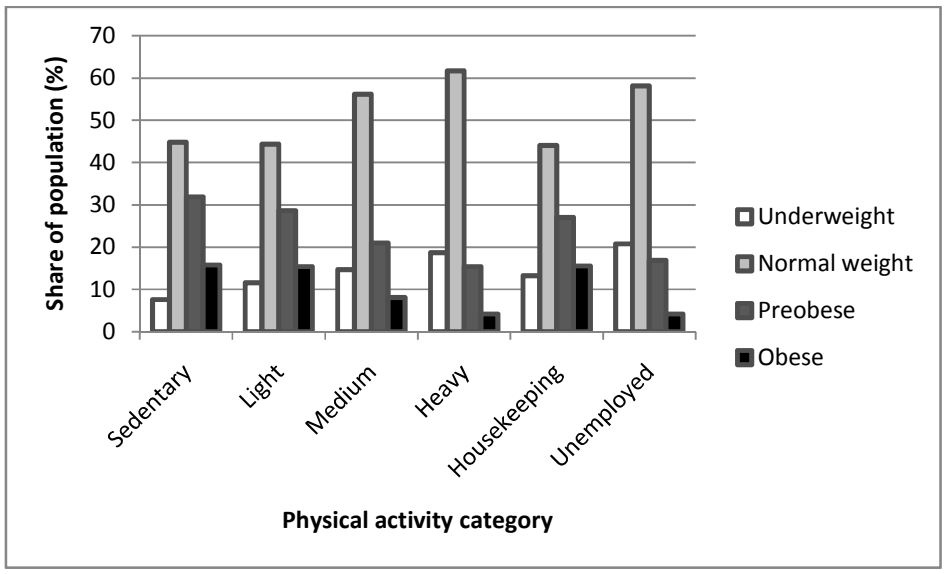
washing machines, fridges, vacuum cleaners) and ownership of a television, which we use as proxies for lower physical activity during leisure time, are positively and significantly correlated with overweight. The association between work-related physical activity and BMI categories is shown in Figure 3. 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.

Table 4 Food expenditures, household appliances, and television ownership by nutritional status (1993, 2000, and 2007)

	Non-overweight		Overweight		
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Diff. in means**
Food expenditures per capita (in 100 thsd. rupiah)	1.563	1.830	2.101	2.211	***
Meat and dairy share	0.149	0.116	0.175	0.121	***
Staple food share	0.236	0.161	0.197	0.148	***
Household appliances (in 100 thsd. rupiah)	13.076	8.433	26.868	17.800	***
Television	0.651	0.477	0.811	0.391	***

Source: IFLS1, IFLS3, IFLS4
Note: *** significant difference between overweight and non-overweight individuals at the 1% level. Asian cut-off values were used for BMI categories. Monetary values were adjusted using the consumer price index. For 1993, no data for television ownership are available.

Figure 3 Work-related physical activity and BMI category (1993, 2000, and 2007)



Source: IFLS1, IFLS3, IFLS4
Note: Asian cut-off values were used for BMI categories.

Regression Analysis

The results of the panel regression models for BMI are shown in Table 5. Positive coefficients indicate that the particular factor tends to increase BMI, while negative coefficients imply a decreasing effect. As expected, higher living standards (measured in terms of per capita expenditure in 100 thsd. rupiah) contribute to higher BMI. The coefficients of the fixed effects models show that an expenditure increase by 100 thousand rupiah (which is a 25% increase over mean expenditure levels) raises BMI by 0.02 and 0.03 among males and females, respectively. While these effects are highly significant, they are quite small, suggesting that there must be other important variables influencing nutritional outcomes. Education has a relatively strong positive effect on BMI for males but not for females. As educational levels of individuals at adult age hardly change over time, for this variable the random effects models provide more efficient estimates. Education is likely to increase nutritional awareness and health knowledge, so it should contribute to higher BMI for those at risk of underweight and to lower BMI for those at risk of overweight. Obesity rates in Indonesia are significantly higher among women; hence, the gender differences in education effects are plausible.

The random effects models show that rural location has a significantly negative effect on BMI for both males and females. This is probably related to higher physical activity levels in rural areas. While we control for work and leisure activities, these control variables do not fully account for infrastructure constraints in rural areas, which tend to increase walking and transportation distances and thus physical exercise. In contrast, being married has a large positive effect, significantly increasing the risk of overweight and obesity, especially for women. This is visible in both the fixed and random effects models. Interpreting the fixed effects coefficients, being married increases female BMI by 0.38. This effect is likely due to cultural factors and changing lifestyles after marriage. Smoking reduces BMI significantly among men and women.

The effects of behavioral variables are shown in the lower part of Table 5. Higher food expenditures contribute to higher BMI for males, as the fixed effects model indicates. Moreover, a higher

expenditure share for traditional staple foods significantly reduces BMI in all models. This confirms the hypothesis that shifting away from traditional diets contributes to rising obesity. Yet, the other food-related variables are insignificant, which we mainly attribute to measurement problems. Aggregated food expenditure data seem to be weak proxies of calorie intake and dietary composition. This may be true in particular when using panel data from different time periods, where changes in food quality and prices are likely to occur.

Results for the physical activity proxies are in line with expectations. We mostly concentrate on the random effects coefficients, because data variation over time is very small for individuals. Lighter physical activity levels during work contribute to higher BMI. For instance, working in a sedentary job, as compared to a job involving heavy physical work, increases BMI by approximately 0.6 for men and women. The results also show that physical activity in leisure time has an important effect on BMI. Owning a television is associated with a 0.23 and 0.44 higher BMI for men and women, respectively, suggesting 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 effects of the socioeconomic and behavioral variables are in addition to a general time trend that is captured by the 2007 dummy. Net of all other effects, BMIs in Indonesia were significantly higher in 2007 than in 2000.

Table 5 Panel regressions explaining BMI (2000 and 2007)

	Male				Female			
	Fixed effects		Random effects		Fixed effects		Random effects	
	Coefficients	*t*-statistics	Coefficients	*t*-statistics	Coefficients	*t*-statistics	Coefficients	*t*-statistics
Constant	19.42***	(24.49)	18.95***	(115.5)	20.96***	(20.27)	19.32***	(84.29)
Expenditures per capita	0.0214**	(2.331)	0.0551***	(6.054)	0.0279**	(2.455)	0.0431***	(4.704)
Education	-0.0775	(-0.784)	0.527***	(12.08)	-0.0599	(-0.463)	0.0833	(1.637)
Rural location	0.0465	(0.510)	-0.205***	(-3.874)	-0.0361	(-0.352)	-0.488***	(-7.698)
Married	0.351***	(3.414)	0.481***	(7.450)	0.376***	(3.724)	0.731***	(10.80)
Smoking	-0.255***	(-2.958)	-0.614***	(-11.39)	0.219	(0.987)	-0.393**	(-2.385)
Food consumption								
Food exp per capita.	0.0366**	(2.098)	0.00123	(0.0733)	-0.00689	(-0.318)	-0.00446	(-0.240)
Meat and dairy share	-0.155	(-0.709)	0.226	(1.242)	-0.265	(-0.984)	0.0418	(0.190)
Staple food share	-0.258*	(-1.682)	-0.529***	(-4.142)	-0.383**	(-2.040)	-0.622***	(-3.987)
Work-related physical activity								
Sedentary work	0.101	(0.735)	0.628***	(5.866)	0.504**	(2.359)	0.662***	(4.145)
Light work	0.127*	(1.698)	0.462***	(8.102)	0.184*	(1.856)	0.740***	(9.649)
Medium work	0.199***	(2.929)	0.326***	(6.196)	0.0600	(0.494)	0.342***	(3.419)
Housekeeping	-0.0623	(-0.469)	-0.0172	(-0.151)	0.110	(1.376)	0.564***	(8.688)
Unemployed	0.232**	(2.032)	0.312***	(3.702)	0.467	(1.051)	0.515*	(1.755)
Leisure-related physical activity								
Possession of television	0.0387	(0.758)	0.234***	(5.647)	0.0516	(0.744)	0.435***	(7.935)
Household appliances	8.16e-06	(0.0103)	0.00216***	(2.654)	0.00243***	(2.918)	0.00199***	(3.262)
2007 dummy	0.356	(1.007)	0.503***	(16.51)	1.415***	(3.085)	0.841***	(21.78)
Observations	18,138		18,138		19,378		19,378	
R-squared	0.237				0.262			
Number of ID	12,647		12,647		13,282		13,282	

Note: ***, **, and * means significant at the 1%, 5%, and 10% level, respectively. Province and age cohort dummies were included in estimation but are not shown for space reasons. Monetary values were adjusted using the consumer price index. Heavy physical work is the omitted reference for work-related physical activity.

Limitations

Our panel data analysis constitutes an improvement over most previous studies building on cross-section data, because we could include a broader set of socioeconomic and behavioral variables to explain BMI and could better account for time trends. Nonetheless, there are a few limitations, which are mostly related to data issues. First, per capita food expenditures are an imperfect proxy for individual level food consumption or intake, since important aspects such as food quality, waste, and intra-household distribution cannot be accounted for. Moreover, the aggregate food expenditure data available in the IFLS did not allow a more detailed analysis of sugar and fat contents or other aspects of dietary composition, which would have been interesting to better understand preference shifts and their nutritional implications. Second, issues of endogeneity in the regression analysis cannot be ruled out completely. While in the fixed effects models we control for unobserved heterogeneity, there may be potential problems of reverse causation. For instance, people with higher BMI may choose jobs or leisure time activities that are physically less strenuous. Such problems can be avoided through use of instrumental variables, as was recently done by Ng et al. (2010) in China. Unfortunately, price measures or other suitable variables that could be used as instruments for behavioral factors are not available in the IFLS.

To test the robustness of the results we tried different sets of variables in the regression analysis. When stepwise excluding food consumption, leisure activity, or work-related variables, the remaining coefficients are mostly robust in terms of signs and significance levels. Some notable changes can be observed for living standard and education effects, but this is expected because these are correlated with behavioral factors. This correlation is also the reason why not including food consumption and physical activity levels may lead to estimation bias. In summary, better data would be useful for more accurate estimates, but our main findings seem to be fairly robust.

Discussion

Our analysis of nutritional trends and determinants among adults confirms that Indonesia is in the process of a fast and profound nutrition transition, with constantly rising obesity rates. Comparing 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 observed in 2000 were similar to the ones in Brazil and China, but not to the ones in India anymore, since in India the nutrition transition has started much later (Jones-Smith et al., 2011b; Lu & Goldman, 2010; Subramanian et al., 2011) Even today, India still has high underweight rates and relatively low overweight rates (Gaiha, Jha, & Kulkarni, 2010). By contrast, in a few other middle income countries, such as South Africa, Mexico, Peru, or in transition countries such as Russia, the nutrition transition has started earlier than in Indonesia (Case & Menendez, 2009; Huffman & Rizov, 2010; Rivera et al., 2004).

The overweight problem in Indonesia is especially pronounced among females. Unlike often believed, rising obesity is not confined to urban and relatively richer households, but is increasingly observed also in rural areas and low income segments. This is in line with findings from a few other developing countries (Jones-Smith et al., 2011b). At the same time, underweight still persists in some pockets of Indonesia. The trends described here are similar to results based on the National Basic Health Survey (Riskesdas) of Indonesia, including prevalence rates when international cut-offs are used (Usfar & Fahmida, 2011; Usfar et al., 2010).

The fast increase in overweight and obesity prevalence rates in developing countries is probably supported by two mechanisms. First, there is a higher risk of overweight in stunted children (Fernald & Neufeld, 2006; Kimani-Murage et al., 2010; Popkin, Richards, & Monteiro, 1996), and overweight in early years is a good predictor for overweight in adult age (Guo, Wu, Chumlea, & Roche, 2002). Second, undernutrition in early childhood and fast weight gain increase the probability of chronic diseases and obesity (Kelishadi, 2007; Victora et al., 2008). Consequently, poverty and food insecurity are not only the main causes for undernutrition, but they indirectly also contribute to the obesity problem. This is

especially true when incomes rise rapidly for some population groups, as is observed in Indonesia and many other developing countries.

Panel regressions have shown that changes in food consumption and physical activity levels are important determinants of BMI in Indonesia. Additional regressions, which were run to explain changes in BMI over time (results not shown), underline that individuals that are already overweight at a certain starting point tend to increase their BMI much more than individuals who start from normal weight. This clearly suggests that the obesity pandemic in Indonesia will further increase in extent and severity, unless significant remedial action is taken. A crucial precondition is that policymakers recognize obesity as a serious health and development issue.

Policy strategies need to raise awareness of the problem and its costs in terms of lost health and life quality. An important starting point is the use of BMI cut-off values for Asian populations in national health and nutrition statistics. Use of higher international cut-offs leads to underestimation of the obesity problem in Indonesia. To improve the situation, broad-based education campaigns towards more balanced diets and physical exercise should be considered, 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 in the longer run.

Education and awareness campaigns may have to be accompanied by measures in the food industry to reduce the usage and consumption of sugar, fat, and salt. In addition to direct regulation of production and advertisement, food labels as well as taxes and subsidies to set incentives towards more healthy foods are options to be further analyzed. Experience from developed countries shows that such policies are sometimes difficult to implement and not always very effective. Tight cooperation between public and private sector entities will be important to instigate sustainable change.

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 imperfect proxies of food consumption and dietary composition. This is a general problem in living standard survey data from developing countries. In order to better understand food preference changes in the nutrition transition, more disaggregated food consumption data are needed, including many more details on processed foods and meals eaten away from home. Availability of price data may help to further reduce possible issues of endogeneity. Databases and survey formats should be better adapted to emerging problems and research directions.

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Appendix

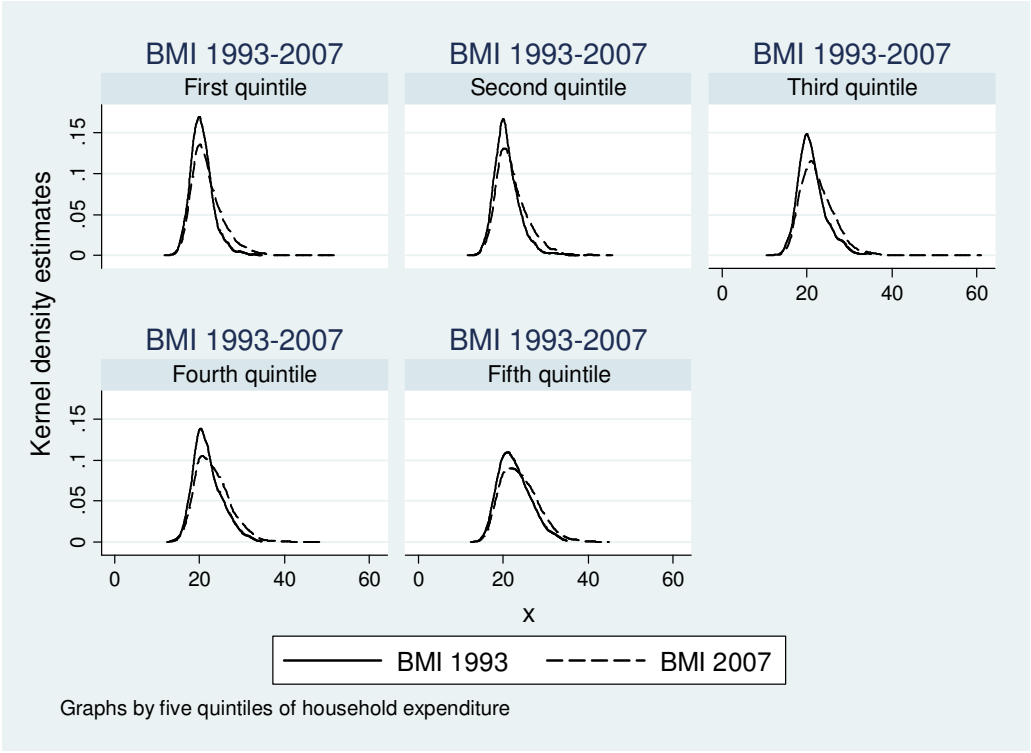
Table A1 Descriptive statistics of sample used for panel regressions (2000 and 2007)

	Male (n=18138)		Female (n=19378)	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Body mass index (BMI)	21.66	3.38	22.99	4.25
Expenditures p.c. (100 thsd. rupiah)	4.10	4.41	4.05	4.42
Education (0-3)	1.60	0.73	1.39	0.80
Rural location (dummy)	0.51	0.50	0.50	0.50
Married (dummy)	0.81	0.39	0.77	0.42
Age (years)	38.76	13.05	39.23	13.42
Smoking (dummy)	0.71	0.46	0.03	0.16
Food consumption				
Food exp p.c. (100 thsd. rupiah)	2.17	2.11	2.10	2.03
Meat and dairy share	0.15	0.11	0.16	0.11
Staple food share	0.21	0.15	0.22	0.15
Work-related physical activity				
Sedentary work (dummy)	0.05	0.22	0.02	0.15
Light work (dummy)	0.28	0.45	0.27	0.44
Medium work (dummy)	0.26	0.44	0.07	0.25
Heavy work (dummy)	0.33	0.47	0.15	0.36
Housekeeping (dummy)	0.02	0.15	0.47	0.50
Unemployed (dummy)	0.06	0.23	0.02	0.12
Leisure-related physical activity				
Possession of television (dummy)	0.71	0.46	0.71	0.45
Household appliances (100 thsd. rupiah)	19.78	63.45	20.14	61.42

Source: IFLS3, IFLS4

Note: Monetary values are adjusted using the consumer price index and expressed in thousand rupiah. Food consumption shares are the share of expenditure for a certain product in total food expenditure of a household. For the education variable, 0 stands for no education, 1 for primary education, 2 for secondary education, and 3 for tertiary education.

Figure A1 BMI distribution by expenditure quintile (1993 and 2007)



Source: IFLS 1, IFLS 4