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Dietary patterns of obese and normal-weight women of reproductive age in urban slum areas in Central Jakarta

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Abstract
Developing countries including Indonesia imperatively require an understanding of factors leading to the emerging problem of obesity, especially within low socio-economic groups, whose dietary pattern may contribute to obesity. In this cross-sectional study, we compared the dietary patterns and food consumption of 103 obese and 104 normal-weight women of reproductive age (19–49 years) in urban slum areas in Central Jakarta. A single 24-h food recall was used to assess energy and macronutrient intakes (carbohydrate, protein and fat) and calculate energy density. A principal component analysis was used to define the dietary patterns from the FFQ. Obese women had significantly higher intakes of energy (8436·6 (SD 2358·1) *v.* 7504·4 (SD 1887·8) kJ (2016·4 (SD 563·6) *v.* 1793·6 (SD 451·2) kcal)), carbohydrate (263·9 (SD 77·0) *v.* 237·6 (SD 63·0) g) and fat (83·11 (SD 31·3) *v.* 70·2 (SD 26·1) g) compared with normal-weight women; however, their protein intake (59·4 (SD 19·1) *v.* 55·9 (SD 18·5) g) and energy density (8·911 (SD 2·30) *v.* 8·58 (SD 1·88) kJ/g (2·13 (SD 0·55) *v.* 2·05 (SD 0·45) kcal/g)) did not differ significantly. Two dietary patterns were revealed and subjectively named 'more healthy' and 'less healthy'. The 'less healthy' pattern was characterised by the consumption of fried foods (snacks, soyabean and roots and tubers) and meat and poultry products, whereas the more healthy pattern was characterised by the consumption of seafood, vegetables, eggs, milk and milk products and non-fried snacks. Subjects with a high score for the more healthy pattern had a lower obesity risk compared with those with a low score. Thus, obesity is associated with high energy intake and unhealthy dietary patterns characterised by consumption of oils and fats through fried foods and snacks.

Key words: **Dietary patterns: Energy density: Food intake: Intake: Obesity**

The emerging obesity prevalence in developing countries is alarming[1–4], especially among women of reproductive age (WRA), and recently this problem has been observed among WRA in the low socio-economic status (SES) population[5]. This increasing number is alarming because obesity increases the risk of non-communicable diseases[1,6], and people with low SES have limited access to the treatment of non-communicable diseases that are the consequences of obesity. Moreover, WRA have the added risk of maternal and neonatal outcomes[7].

Obesity is multifactorial, and each factor may lead to obesity as single factor or in combination with other factors[8,9]. However, obesity mainly results from energy imbalance, which is directly associated with food intake and physical activity[1].

The total energy intake is considered one of the dietary determinants that influences weight gain[10] and obesity[11]. Recent studies have shown that high energy density is associated with high energy and fat intakes and low vegetable and fruit intakes[11]. Energy density of food is influenced by the type and variety of food consumed[12]. Consumption of refined grains, added sugars and fats, snacks, beverages, fast foods and eating out of home contribute towards the intake of high energy-dense food[13]. The food consumed by people determines their dietary pattern. Moreover, people from the low SES population consume high energy-dense food because it is more accessible and affordable[14]. However, evidence on the type of energy-dense food and dietary pattern leading to obesity in the low SES population is not yet convincing, especially in developing countries.

The present study used the Indonesian population data, because according to the 2010 Indonesian Basic Health Research Survey[15] the prevalence of obesity among adult Indonesian men and women is 7·8 and 15·5 %, respectively, which increased to 19·7 and 32·9 %, respectively, in 2013[16]. Moreover, the prevalence of obesity was higher in urban areas than in rural areas. Khusun[17] demonstrated that the prevalence of overweight

Abbreviations: SES, socio-economic status; WRA, women of reproductive age.

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condition among low SES women in Indonesia increased from 15·6 % in 1993 and 21·8 % in 2000 to 30 % in 2007.

People should be informed on strategies for reducing energy intake in terms of the types of food and dietary patterns contributing to high energy intake, through simple informative messages on nutritional habits. Such public awareness measures are crucial considering the increasing prevalence of obesity among the low SES population. Studies exploring specific food consumption and intake patterns contributing to obesity among urban low SES women are limited. Therefore, we assessed the association of food intake and dietary pattern with obesity among women of the low SES population living in urban slum areas.

Methods

Study population and sampling procedure

This comparative cross-sectional study was conducted from February to April 2013, and a multi-stage random sampling method was used to enrol study subjects from three randomly selected slum areas in Central Jakarta – namely, Kebon Melati, Mangga Dua Selatan and Pegangsaan Village. In all, 600 apparently healthy women aged 19–49 years were screened for determining obese and normal-weight conditions according to BMI cut-off points for Asian people[18]. Pregnant and women with disabilities were excluded from this study. From the 600 subjects screened, 110 normal-weight and 110 obese subjects were randomly selected. The sample size was calculated by estimating differences in the mean energy intake among obese and normal-weight women with 80 % power, 95 % significance level and an expected mean difference of 2179·8 kJ (521 kcal)[19]. The final study subjects were 103 obese and 104 normal-weight women, because one subject refused to continue with the study, two subjects returned to their villages during data collection and the energy intake for four and six subjects were under-reported and over-reported, respectively.

Anthropometric measurement

Body weight and height were measured using standardised procedures[20]. Body weight was measured using a SECA electronic weighing scale (Seca GmbH) to the nearest 0·1 kg. Height was measured using a Shorr Board (Shorr Productions LLC) to the nearest 0·1 cm. Weight and height measurements were recorded twice for each subject, and the average values of these two measurements were recorded for analysis. The BMI was calculated as weight (kg) divided by the square of height (m^2). Subjects with BMI $\geq$ 27·5 kg/m^2 were classified as obese and those with BMI = 18·5–22·99 kg/m^2 were classified as normal-weight subjects[18].

Structured interview

Structured interviews were conducted to collect information on the socio-demographic characteristics and physical activities of the study population. The International Physical Activity Questionnaire (IPAQ; short, 7-d recall) was used for assessing the physical activities of the study subjects. This questionnaire assesses walking and moderate- and vigorous-intensity physical activity profiles. Physical activity was expressed as the metabolic equivalent of task (MET)-min/week. According to the International Physical Activity Questionnaire[21], the total MET-min/week score was categorised into three levels of physical activity: low, moderate and high.

Dietary assessment

Dietary habits of all study subjects were assessed using a single 24-h food recall and FFQ. The under-reporting of energy intake was defined using the Goldberg cut-off[22] with a 99·7 % confidence limit. The over-reporting of energy intake was predicted on the basis of total energy expenditure values developed by McCrory *et al.*[23].

Single 24-h food recall

Subjects were asked to recall their exact food intake, including beverages, during the previous 24-h period or the preceding day[20]. Subjects were also asked to recall the portion size, processing method and composition of the food consumed. Sample food models were used to help the subjects assess their food portion sizes.

FFQ

The FFQ was developed after a group interview involving eleven normal-weight and twelve obese women from the study area. From the food items collected during the group interview, ninety-nine items including ninety foods and nine beverages were included in the FFQ. The study subjects were asked how often, on average, they consumed the foods over the previous 1 month[24]. The frequencies were categorised as never, 1–6 times/d, 1–6 times/week and 1–3 times/month. The frequency of consumption of each food item was calculated as the frequency of consumption per month.

The ninety-nine food items that were part of the FFQ were divided into twenty-two food groups (eighteen food and four beverage groups) for assessing the dietary patterns among the normal-weight and obese women. The food groups were based on similarity of their nutrient profiles, culinary usage among the foods or specific nutrients as study interests. Dietary patterns were explored through principle component analysis (PCA).

Data analyses

Data were analysed using SPSS version 16.00 (IBM). Normal distribution of data was analysed using the Kolmogorov–Smirnov test. Descriptive data are presented as mean values and standard deviations. χ^2 and t tests were used for assessing the association between variables and obesity status, with a significance level of 0·05. Energy and macronutrient intakes and energy density were calculated from the single 24-h food recall. Data from the single 24-h food recall were converted into energy and macronutrient intakes using NutriSurvey software for Windows 2004 and were calculated as the average of the mean intake.

The energy density of each subject was calculated by dividing the energy (kJ (kcal)) obtained from total food consumed, including beverages, within 24 h by the weight (g) of total consumed food, excluding the weight of all beverages[25,26]. The energy density for each group was determined by calculating the average energy density of all subjects in each group. The calculated energy density was classified into three groups according to the rankings of the energy density value of each subject from the tertile study samples. The first, second and third tertiles projected low, moderate and high energy densities, respectively.

Dietary patterns were identified from the FFQ. The factor analysis for the FFQ was performed through PCA for all twenty-two food groups included in the FFQ, and the factor solutions were expressed as frequency consumption per month. The factor analysis solutions were limited to the factors with an eigenvalue >1[27]. Eigenvalue >1 denotes that the factor is a possible variable in the correlation[28]. An orthogonal transformation using a varimax rotation was used for rotating the factors. This rotation was used for improving the interpretation and obtaining independent dietary patterns. Two factors that gave the highest variance explained were used for the analyses. The final factor solution after the rotations provided factor loadings for each factor or dietary patterns[27]. The factor loadings represent the importance of a food group for determining the dietary patterns[29]. A positive loading means that the food group was positively associated with the investigated dietary pattern score, whereas a negative loading means that the food group is not associated with the dietary pattern score[15]. Moreover, a high factor loading suggests a large contribution from the food group towards the investigated dietary pattern[30]. Food groups with absolute factor loading >0·30 were considered significant contributors to dietary patterns[31]. All food groups considered for the final factor solutions were used for calculating dietary pattern scores[27]. The factor score for each subject was calculated by summing the intake of each food group weighted by the factor loadings, and the factor score for each dietary pattern was calculated by summing the factor scores of all subjects[24].

Logistics regression analyses through the enter method were performed for exploring the association between a dietary pattern and the subject's weight status. Two steps of modelling were used. In model 1, only dietary pattern score variables were included. In model 2, all possible confounders were included – namely, energy intake, energy density, age, marital status, smoking status, physical activity and occupation.

Results

The screening results (*n* 600) revealed that over-nutrition was substantially high in the study area; 68·1 % of the women screened were overweight or obese. The obesity prevalence was 37·5 %, evidencing the gravity of the already-high over-nutrition problem in urban slum areas. In total, data of 103 obese and 104 normal-weight women were analysed after screening and were compared for answering the study objective.

Table 1 shows the general characteristics of the study subjects. Age, ethnicity, marital status, occupation and education status of the obese and normal-weight women did not differ significantly. Most subjects were 30–49 years old, had Javanese ethnicity, married, unemployed and had completed junior and senior high school (29·8–33 % and 32–32·7 %, respectively) education. Furthermore, smoking status, use of hormonal contraceptives, parity and physical activity of the obese and normal-weight subjects also did not differ significantly. More than 70 % of the subjects were non-smokers, approximately 50 % used hormonal contraceptives and approximately 60 % had <3 children. Approximately 5, 47 and 48 % of the subjects showed low, moderate and high physical activity levels, respectively.

Energy and macronutrient intake and energy density

Table 2 lists the energy intake of the normal-weight and obese subjects. The energy, carbohydrate and fat intakes of the obese subjects were significantly higher ($P<0·05$) than those of the normal-weight subjects. The difference in the mean energy intake of the obese and normal-weight subjects was 929 kJ (222 kcal), whereas the mean energy differences for carbohydrate and fat intakes were 26 and 13 g/d, respectively. The protein intake and energy density did not differ significantly between the obese and normal-weight subjects; however, the mean energy density of the obese subjects was slightly higher than that of the normal-weight subjects.

Dietary patterns

Table 3 shows the separation of the food items consumed by the subjects according to their nutritive values into twenty-two food groups as follows: staple food, root and tuber, meat and poultry, seafood, organ meat, eggs, fried soyabean and soyabean products, non-fried soyabean and soyabean products, vegetables, mixed food, fruits, *rujak* (fruit salad in palm sugar dressing), fried snacks, non-fried snacks, biscuits and crackers, desserts, peanuts, oils and fats, sugar-sweetened beverages, milk and milk products, tea and coffee without sugar and tea and coffee with sugar and milk. Most food items in each food group were Indonesian traditional dishes.

These twenty-two food groups were analysed through PCA, and the results are shown in Table 4. Two dietary patterns were revealed through PCA and subjectively named 'more healthy' and 'less healthy' based on their general nutritional values. The food groups with <0·30 factor loading – namely, sugar-sweetened beverages, tea and coffee without sugar and tea and coffee with sugar and milk – were excluded from the list. Moreover, four food groups that did not match the dietary pattern criteria based on their nutritional value were excluded from the list. The factor loading of desserts and organ meat were high in the 'more healthy' pattern, while the foods were actually considered unhealthy. On the other hand, the factor loadings of *rujak* and non-fried soyabean products were high in the 'less healthy' pattern, while the foods were actually considered healthy.

Food groups with >0·30 factor loading were considered as contributors to the dietary patterns. The more healthy pattern was comprised of food items with high factor loadings – namely, biscuits and crackers, fruits, non-fried snacks, seafood, peanuts, composite foods, staples, vegetables, milk and milk

Table 1. General characteristics of the subjects

	General characteristics	Normal weight (*n* 104) (%)	Obese (*n* 103) (%)	*P**
1.	Age			
	19–29 (years)	20·2	18·4	0·107
	30–39 (years)	47·1	35·0	
	40–49 (years)	32·7	46·6	
2.	Marital status (%)			
	Single or formerly married	12·5	8·7	0·380
	Married	87·5	91·3	
3.	Level of education (%)			
	No schooling	8·7	10·7	0·911
	Completed elementary school	26·9	23·3	
	Completed junior high school	29·8	33·0	
	Completed senior high school	32·7	32·0	
	Completed university or higher education	1·9	1·0	
4.	Occupation (%)			
	Employment	19·1	22·4	0·574
	Unemployment	80·9	77·6	
5.	Ethnicity (%)			
	Sumateranese (Batak, Padang)	1·0	5·9	0·065
	Javanese (Betawi, Sunda, Jawa)	99·0	94·1	
6.	Smoking status (%)			
	Past	6·7	12·6	0·164
	Current	10·6	15·5	
	No smoking	82·7	71·8	
7.	Use of contraceptives (%)			
	Yes	44·7	51·5	0·403
8.	Parity (%)			
	<3	66·0	58·3	0·315
	≤3	34·0	41·7	
9.	Physical activity (%)			
	Low	5·8	4·9	0·92
	Moderate	47·1	49·5	
	High	47·1	46·4	

* χ^2 Test.

Table 2. Energy and macronutrient intakes and energy density of normal-weight and obese subjects
(Mean values and standard deviations)

		Normal weight (*n* 104)		Obese (*n* 103)		
No.	Intake	Mean	SD	Mean	SD	*P*†
1.	Total energy intake (kJ/d)	7504·4	1887·8	8436·6	2358·1	
	Total energy intake (kcal/d)	1793·6	451·2	2016·4	563·6	0·002*
2.	Carbohydrate (g/d)	237·6	63·0	263·9	77·0	0·008*
3.	Protein (g/d)	55·9	18·5	59·4	19·1	0·182
4.	Fat (g/d)	70·2	26·1	83·1	31·3	0·001*
	Energy density (kJ/g per d)	8·58	1·88	8·91	2·30	
5.	Energy density (kcal/g per d)	2·05	0·45	2·13	0·55	0·254

* $P<0·05$.
† *t* Test.

products and eggs; this patterns was considered more healthy because of the high factor loadings of fruits, vegetables and seafood. Moreover, the snacks included in this pattern were non-fried snacks. The less healthy pattern included food items with high factor loadings – namely, fried foods (fried snacks and soyabean and soyabean products) and oils and fats.

Association between the dietary patterns and BMI

Table 5 lists the logistic regression results, which indicate an association between dietary patterns and the nutritional status. Before adjustment for possible confounders (model 1), a high quintile score of the more healthy pattern was protective against obesity (OR 0·55; 95 % CI 0·22, 1·38), and a high quintile score of the less healthy pattern showed an increased risk of obesity (OR 1·60; 95 % CI 0·67, 4·22); however, the association was non-significant. After adjustment for possible confounding factors – namely, energy intake, energy density, age, marital status, smoking status, physical activity and occupation (model 2) – the association between the dietary pattern scores and nutritional status was stronger. The risk of obesity among subjects in the fourth to fifth quintile of the more healthy pattern score was three times lower than that among subjects in the first to third quintiles (OR 0·33; 95 % CI 0·12, 0·94). However, the obesity

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Table 3. Classification of food items according to nutrient profiles

Food groups	Food items
Biscuit, crackers	All kinds of biscuits and crackers
Fruits	Avocado, apple, banana, duku, orange, papaya, pier, watermelon
Rujak (fruit salad)	(Mixed fruits: mango, cucumber, papaya – eaten with palm sugar)
Fried snacks	Fried *bakwan*, *cakwe*, *cireng*, doughnut, chips, cassava chips, salty egg *martabak*, fried fish ball, *pempek* (fried fish cake), fried banana, *risol/pastel*
Non-fried snacks	Boiled maize, sticky rice, cakes, rice cake, bread
Meat and poultry	Fried chicken, fried chicken with vegetables, Kentucky fried chicken, chicken nuggets, chicken *opor*, *rendang*, chicken *satay*, grilled sausages, fried sausages
Fish and seafood	Steam fish, fried squid, stir-fry squid, fried fish, fried anchovy, fried anchovy with peanuts, spicy anchovy, fried shrimp, spicy fried shrimp
Peanuts	Peanuts coated with flour, roasted peanuts
Oil and fats	Margarine, additional oil, oil for frying or cooking
Composite foods	Meat ball, *ketoprak*, vegetable soup rice cake, *siomay*, chicken soto, noodle *soto*
Desert	Sweet rice-based or flour-based traditional cakes
Staples	*Kwetiau*, chicken porridge, noodle, instant noodle, fried vermicelli, instant vermicelli, rice, fried rice, rice (with coconut milk), *uduk* rice, yellow rice, *Padang* rice
Sugar-sweetened beverages	Carbonated soft drinks, flavoured fruit drinks
Organ meat	Fried or stewed offal
Vegetables	Low-calorie vegetable (raw or boiled), low-calorie vegetable (stir fry), medium-calorie vegetable (raw or boiled), medium-calorie vegetable (stir fry), high-calorie vegetable (raw or boiled), high-calorie vegetable (cooked with coconut milk), hot eggplants, sour mixed vegetable, mixed vegetable soup, vegetable with coconut milk dish (*lodeh*), Indonesian salad
Fried soyabean product	Fried tofu, fried tofu with vegetables, fried *tempe*, fried crispy *tempe*, sweet *tempe*, sweet and spicy *tempe*
Non-fried soyabean product	Steamed tofu or *tempe*
Milk and milk product	Milk powder, condensed milk, cereal, yoghurt
Tea, coffee	Plain tea or coffee
Tea, coffee with additional energy content	Tea or coffee with sugar, milk or creamer
Eggs	Boiled eggs, fried eggs, spicy fried eggs
Root, tubers	Steam root and tubers, fried root and tubers (cassava, potatoes, sweet potato), fried potatoes, fried potatoes with chilli

Table 4. Factor loadings obtained through principle component analysis for food groups that characterise the dietary patterns

No.	Food group	'More healthy' pattern	'Less healthy' pattern
1.	Biscuit, crackers	0·436	–
2.	Fruits	0·405	–
3.	Fried snacks	–	0·534
4.	Non-fried snacks	0·532	–
5.	Meat and poultry*	–	0·440
6.	Fish and seafood	0·409	–
7.	Peanuts	0·377	–
8.	Oil and fats	–	0·733
9.	Composite foods	0·579	–
10.	Staples	0·505	–
11.	Vegetables	0·462	–
12.	Fried soyabean products	–	0·627
13.	Milk and milk product	0·454	–
14.	Eggs	0·478	–
15.	Roots and tubers*	–	0·469

* Mostly consumed as fried foods.

risk among subjects in the fourth to fifth quintile of the less healthy pattern score was 2·7 times higher than that among subjects in the first to third quintiles (OR 2·7; 95 % CI 0·95, 7·70). Energy intake was significantly associated with obesity. The obesity risk of subjects with an energy intake of >86 % of the reference daily intake (RDA) was 2·7 times higher than that among subjects with an intake of <86 % (OR 2·7; 95 % CI 1·38, 5·41). Married subjects were more obese compared with unmarried subjects (OR 2·16; 95 % CI 0·73, 6·36); marital status had no significant association with the risk of obesity.

Discussion

According to the 2010 Basic Health Research Survey, overweight and obesity levels in the community analysed in the present study were substantially higher than the overall overweight and obesity levels in Jakarta[15]. High overweight and obesity levels are concerning, especially considering the low SES of the urban slum community. The results of this study confirmed the hypotheses of the overweight problem in developing countries by showing evidence of problems related

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Table 5. Crude and adjusted OR for obesity according to dietary patterns
(Odds ratios and 95 % confidence intervals)

	Model 1*		Model 2*	
Factors	OR	95 % CI	OR	95 % CI
More healthy pattern				
Quintile 1–3	1	Ref.	1	Ref.
Quintile 4–5	0·55	0·22, 1·38	0·33	0·12, 0·94
Less healthy pattern				
Quintile 1–3	1	Ref.	1	Ref.
Quintile 4–5	1·69	0·67, 4·22	2·7	0·95, 7·70
Energy intake				
≤86 % RDA			1	Ref.
>86 % RDA			2·73	1·38, 5·41
Energy density				
Low (tertile 1)			1	Ref.
Medium			1·07	0·49, 2·32
High (tertile 3)			1·40	0·63, 3·09
Physiological				
Age group				
19–29 years			1	Ref.
30–39 years			0·53	0·23, 1·26
40–49 years			1·37	0·59, 3·19
Marital status				
Unmarried			1	Ref.
Married			2·16	0·73, 6·36
Behaviour				
Smoking				
Current smoking			1	Ref.
No smoking			0·62	0·24, 1·58
Physical activity				
Low			1	Ref.
Medium			0·96	0·51, 1·83
High			1·43	0·35, 5·78
Socio-economic status				
Occupation				
Employment			1	Ref.
Unemployment			1·20	0·55, 2·60
R^2	0·01		0·14	

Ref., referent values.
* Binary logistic regression with the enter method.

to high overweight and obesity levels, even in the slum community.

This study showed that energy intake was significantly higher among the obese than among the normal-weight subjects, even after adjustment for the dietary patterns and other potential confounding variables. This finding is consistent with the findings of similar studies from other countries[32,33] and confirms reports that high energy intake is the main determinant of obesity[1,10]. The macronutrients that contributed to energy, carbohydrate and fat intakes were significantly higher among the obese than among the normal-weight subjects; however, no significant difference was observed for protein intake. Thus, obesity prevalence among women from the low SES population enrolled in this study was associated with high carbohydrate and fat intakes but low protein intake. The results clarified the contribution of carbohydrate intake to obesity, as reported in other studies[32,34,35]. Moreover, the contribution of fat intake towards obesity in this community was confirmed and was consistent with results of similar studies conducted in other countries[35–37].

No significant difference was observed in the energy density among obese and normal-weight subjects. This result was inconsistent with some studies that reported that energy density is associated with obesity[9,38–40]; however, various other studies have reported no association[38,41]. This inconsistency was partly related to the non-uniformity in calculating energy density, particularly in the treatment of beverages; inclusion of all food items and beverages weakened the association between energy density with the outcome[25] because the weight of beverages increased the day to day variations in the subject's food consumption. In this study, the weight of beverages were excluded from the energy density calculations; however, this method also had a limitation because a subject who primarily drinks water would have high energy density values, and the effect of energy-containing beverages may be underestimated. However, the food consumed by the population under consideration in this study had relatively high energy density compared with that of the American population (6·7–8·45 kJ/g (1·6–2·02 kcal/g)) depending on age and calculated using similar method)[25]. Therefore, despite the lack of an association, high energy density food consumption should be considered a crucial obesity risk factor for this population.

Two dietary patterns were observed in this study and subjectively named more healthy and less healthy patterns. The food groups in the 'more healthy' pattern were considered healthier compared with those in the 'less healthy' pattern because the more healthy food groups included less or moderate oil and fats. In contrast to the 'more healthy' pattern, most food groups in the 'less healthy' pattern contained food items with oils and fats, mainly because of oil and food processing. Besides fried snacks and fried soyabean products, roots and tubers and meat and poultry products were the most consumed fried foods.

After adjustment for energy intake, energy density and other socio-demographic variables, the two dietary patterns showed an association with the BMI status. Subjects with a high quintile score in the 'more healthy' pattern had a lower risk of obesity than did those with a low score. Consistent with this result, subjects with a high quintile score in the 'less healthy' pattern had a high risk of obesity than did those with a low score. These results are consistent with those of similar studies from other countries, which have reported that intake patterns with a high intake of meat, fat, oil and sweets were associated with an increased risk of overweight and obesity, whereas a 'healthy pattern' with a high intake of vegetables, fruits, fish and whole grain was associated with a lower risk[42–44]. However, in some other countries, considering the two dietary patterns, no association between the BMI and risk of obesity has been observed[45,46]. These inconsistencies[47] are likely attributable to the differences in the classification of foods and in the dietary assessment and analytical methods used.

The identified association became stronger after adjustment for energy intake, suggesting that the dietary pattern is a stronger influencer than is energy intake. Dietary patterns give a broader picture of food and nutrient consumption for studying the association between diet and a health outcome. Dietary patterns describe the whole diet, including the potential synergetic effects of foods and nutrients[48].

Strengths and limitations of the study

This study was among the very few that have characterised food intake among obese and normal-weight women in urban slum areas in Indonesia. We used a comprehensive procedure to ensure clearer estimation of the food portion size and nutrient content, such as weighting duplicate food portions reported by the subjects and the cooking approach for foods with no available data on their nutrient contents in the food composition database. However, there were several weaknesses that may have influenced our study. The cross-sectional design of this study limited the ability of assessing the causal relationship between food intake and obesity status. Moreover, the physical activity assessment and 24-h food recall were prone to underestimation and overestimation; therefore, a study with specific settings is required to ensure validity and reliability of physical activity assessment. Alves *et al.*[19], who assessed physical activity among obese women in urban slum areas in Brazil using the IPAQ 7-d short version, the same as that used in this study, showed that the assessment tools cannot distinguish leisure, occupation, household or transportation activities, which would had been useful for understanding behaviour patterns in the slum population[24].

Conclusion and recommendation

The over-nutrition problem in our study population was severe, and the significance of food consumption in the risk of obesity was identified. Obese WRA had higher energy, carbohydrate and fat intakes than normal-weight WRA. Two dietary patterns were identified in this study: the 'more healthy' and 'less healthy' patterns. The 'less healthy' pattern was characterised by consumption of fried foods (snacks, soyabean, roots and tubers and meat and poultry products), whereas the 'more healthy' pattern was characterised by consumption of seafood, vegetables, eggs, milk and milk products and non-fried snacks. The dietary patterns were significantly associated with obesity. Furthermore, a high quintile score of the 'more healthy' pattern was associated with a low risk of obesity, whereas a high quintile score of the 'less healthy' pattern was associated with a high risk of obesity. Therefore, to overcome the obesity problem in this population, educating people on nutritional values is required for improving their diet and the type and portion of food consumed. Moreover, the population in urban slums have limited access to various food choices; therefore, investigating the association between food environment and dietary patterns is warranted. Consistent with the association of high energy intake with obesity, physical activity should be increased to compensate for the higher energy intake. Additional studies are required for validating the assessment of physical activity measurements among the study population.

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The authors declare that there are no conflicts of interest.

References

1. World Health Organization (2000) Obesity: Preventing and Managing the Global Epidemic. *Report of a WHO Consultation, WHO Technical Series*, no. 894. Geneva: WHO.
2. Prentice AM (2006) The emerging epidemic of obesity in developing countries. *Int J Epidemiol* **35**, 93–99.
3. Asia Pacific Cohort Study Collaboration (2007) The burden of overweight and obesity in the Asia-Pacific region. *Obes Rev* **8**, 191–196.
4. Wang Y & Lobstein T (2006) Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* **1**, 11–25.
5. Ezzati M, Vander Hoorn S, Lawes CM, *et al.* (2005) Rethinking the 'diseases of affluence' paradigm: global patterns of nutritional risks in relation to economic development. *PLoS Med* **2**, p. e133.

6. World Health Organization (2010) *Global Status Report on Non Communicable Diseases*. Geneva: WHO.
7. Rowlands I, Graves N, De Jersey S, *et al.* (2010) Obesity in pregnancy: outcomes and economics. *Semin Fetal Neonatal Med* 15, 94–99.
8. Jebb SA (2007) Dietary determinants of obesity. *Obes Rev* **8**, Suppl. 1, 93–97.
9. James WP (2008) The fundamental drivers of the obesity epidemic. *Obes Rev* **9**, Suppl. 1, p. 6–13.
10. Du H (2010) Dietary determinants of obesity. *Acta Cardiol* **65**, 377–386.
11. Kant AK & Graubard BI (2005) Energy density of diets reported by American adults: association with food group intake, nutrient intake, and body weight. *Int J Obes (Lond)* **29**, 950–956.
12. Ello-Martin JA, Ledikwe JH & Rolls BJ (2005) The influence of food portion size and energy density on energy intake: implications for weight management. *Am J Clin Nutr* **82**, Suppl., 236S–241S.
13. Drewnowski A (2009) Obesity, diets, and social inequalities. *Nutr Rev* **67**, Suppl. 1, S36–S39.
14. Aguilar J (2010) *The Fattening of America: Analysis of the Link between Obesity and Low Income*. Stanford, CA: Leland Stanford Junior University.
15. Basic Health Research and Development Agency & Ministries of Health (2010) *Riset kesehatan dasar*. Jakarta: Health Research and Development Agency & Ministries of Health.
16. Basic Health Research and Development Agency & Ministries of Health (2013) *Riset kesehatan dasar*. Jakarta: Health Research and Development Agency & Ministries of Health.
17. Khusun H (2011) Explaining the heterogeneity in overweight and underweight amongst adult Indonesians, 1993–2007: the influence of compositional and contextual factors. PhD Thesis. School of Population Health, The University of Queensland, Australia.
18. World Health Organization (2004) Public health appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* **363**, 157–163.
19. Alves JG, Falcão RW, Pinto RA, *et al.* (2011) Obesity patterns among women in a slum area in Brazil. *J Health Popul Nutr* **29**, 286–289.
20. Gibson RS (2005) *Principles of Nutritional Assessment*, 2nd ed. New York: Oxford University Press.
21. International Physical Activity Questionnaire (2005) International Physical Activity Questionnaire (IPAQ)-short last 7 days. www.ipaq.ki.se (accessed September 2012).
22. Goldberg GR, Black AE, Jebb SA, *et al.* (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off-limits to identify under-recording. *Eur J Clin Nutr* **45**, 569–581.
23. McCrory MA, Hadjuk CL & Roberts SB (2002) Procedures for screening out inaccurate reports of dietary intake. *Public Health Nutr* **5**, 873–882.
24. Khani BR, Ye W, Terry P, *et al.* (2004) Reproducibility and validity of major dietary patterns among Swedish women assessed with a food-frequency questionnaire. *J Nutr* **134**, 1541–1545.
25. Ledikwe JH, Blanck HM, Khan LK, *et al.* (2005) Dietary energy density determined by eight calculation methods in a nationally representative United States population. *J Nutr* **135**, 273–278.
26. Ledikwe JH, Blanck HM, Khan LK, *et al.* (2006) Dietary energy density is associated with energy intake and weight Status in US adults. *Am J Clin Nutr* **83**, 1362–1368.
27. Ambrosini GL, Sullivan TAO, de Klerk NH, *et al.* (2012) Relative validity of adolescent dietary patterns : comparison of a food frequency questionnaire and 3-day food record. *Br J Nutr* **105**, 625–633.
28. Newby PK, Sc D & Tucker KL (2004) Empirically derived eating patterns using factor or cluster analysis : a review. *Nutr Rev* **62**, 177–203.
29. Sichieri R (2002) Dietary patterns and their associations with obesity in the Brazilian city of Rio de Janeiro. *Obes Res* **10**, 42–48.
30. Hu FB, Rimm E, Smith-warner SA, *et al.* (1999) Reproducibility and validity of dietary patterns assessed with a food frequency questionnaire. *Am J Clin Nutr* **69**, 243–249.
31. Field A. (2005) *Discovering Statistic Using SPSS*, 3rd ed. London: SAGE Publications Ltd.
32. Mokhtar N, Elati J, Chabir R, *et al.* (2001) Symposium : obesity in developing countries : biological and ecological factors diet culture and obesity in Northern Africa 1. *J Nutr* **131**, Suppl., 887–892.
33. Colditz GA, Willet WC, Stampfer MJ, *et al.* (1990) Patterns of weight change and their relation to diet in a cohort of healthy women. *Am J Clin Nutr* **51**, 1100–1105.
34. Ma Y, Olendzki B, Chiriboga D, *et al.* (2005) Association between dietary carbohydrates and body weight. *Am J Epidemiol* **161**, 359–367.
35. Mills JP, Perry CD & Reicks M (2011) Eating frequency is associated with energy intake but not obesity in midlife women. *Obesity (Silver Spring)* **19**, 552–559.
36. Field AE, Willett WC, Lissner L, *et al.* (2007) Dietary fat and weight gain among women in the Nurses' Health Study. *Obesity (Silver Spring)* **15**, 967–976.
37. Ravussin E & Tataranni PA (1997) Dietary fat and human obesity. *J Am Diet Assoc* **97**, Suppl., S42–S46.
38. Bes-Rastrollo M, Van Dam RM, Martinez-Gonzalez MA, *et al.* (2008) Prospective study of dietary energy density and weight gain in women. *Am J Clin Nutr* **88**, 769–777.
39. Howarth NC, Murphy SP, Wilkens LR, *et al.* (2006) Dietary energy density is associated with overweight status among 5 ethnic groups in the multiethnic cohort study. *J Nutr* **136**, 2243–2248.
40. Mendoza JA, Drewnowski A. & Christakis DA (2007) Dietary energy density is associated with obesity and the metabolic syndrome in U.S. adults. *Diabetes Care* **30**, 974–979.
41. Stookey JD (2001) Energy density, energy intake and weight status in a large free-living sample of Chinese adults: exploring the underlying roles of fat, protein, carbohydrate, fiber and water intakes. *Eur J Clin Nutr* **55**, 349–359.
42. Okubo H, Sasaki S, Murakami K, *et al.* (2008) Three major dietary patterns are all independently related to the risk of obesity among 3760 Japanese women aged 18–20 years. *Int J Obes (Lond)* **32**, 541–549.
43. Esmaillzadeh A & Azadbakht L (2008) Major dietary patterns in relation to general obesity and central adiposity among Iranian women. *J Nutr* **138**, 358–363.
44. Dugee O, Khor GL, Lye MS, *et al.* (2009) Association of major dietary patterns with obesity risk among Mongolian men and women. *Asia Pac J Clin Nutr* **18**, 433–440.
45. Song Y, Joung H, Engelhardt K, *et al.* (2005) Traditional *v.* modified dietary patterns and their influence on adolescents' nutritional profile. *Br J Nutr* **93**, 943–949.
46. Shi Z, Hu X, Yuan B, *et al.* (2008) Vegetable-rich food pattern is related to obesity in China. *Int J Obes (Lond)* **32**, 975–984.
47. Togo P, Osler M, Sorensen TIA, *et al.* (2001) Food intake patterns and body mass index in observational studies. *Int J Obes Relat Metab Disord* **25**, 1741–1751.
48. Hu FB (2002) Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* **13**, 3–9.