Original Article

# Food variety score is associated with dual burden of malnutrition in *Orang Asli* (Malaysian indigenous peoples) households: implications for health promotion

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This paper reports on the presence of dual burden households in Orang Asli (OA, indigenous people) communities and its associated factors. A total of 182 OA households in two districts in Selangor with the required criteria (182 non-pregnant women of child bearing age and 284 children aged 2-9 years old) participated in the study. Height and weight of both women and children were measured. Energy intake and food variety score (FVS) were determined using three 24-hour diet recalls. While 58% were underweight and 64% of the children were stunted, the prevalence of overweight and obesity in women were 31% and 20% respectively. The percentage of dual burden households (overweight mother/underweight child) was 25.8% while 14.8% households had normal weight mother/normal weight child. The mean food variety score (FVS) was similar for women (7.0±2.1) and children (6.9±1.9). Dual burden households were associated with women's employment status (OR: 3.18, 95% CI: 2.65-5.66), FVS of children (OR: 0.71, 95% CI: 0.51-0.95) and FVS of women (OR: 1.39, 95% CI: 1.02-1.89). The FVS of children (OR: 0.49, 95% CI: 0.25-0.89) and women (OR: 1.92, 95% CI: 1.64-2.77) remained significant even when dual burden households were compared to only households with normal weight mother/normal weight child. In these OA communities, food variety may predict a healthier diet in children, but may increase the risk of overweight and obesity in adults. Efforts to address households with dual burden malnutrition should consider promotion of healthy diets and lifestyle for all members.

**Key Words: indigenous peoples, dual burden of malnutrition, food variety, overweight, underweight**

## INTRODUCTION

In many developing countries, while under-nutrition remains prevalent in children, overweight and obesity among adults is increasing at an alarming rate.[1] Childhood undernutrition manifested in growth stunting or underweight, has adverse consequences on child survival and cognition which could later impact adult economic productivity and elevate the predisposition to obesity and chronic diseases in adulthood.[2] Concomitant with the marked increase in adult adiposity is the escalating prevalence of non-communicable chronic diseases such as diabetes mellitus type 2, hypertension and cardiovascular diseases.[3]

Women, urbanization and improvements in socioeconomic status of the populations are associated with the rapid rise in overweight and obesity prevalence.[4,5] However, a review on the relationship between socioeconomic status and obesity in developing countries indicated that obesity prevails not only among higher socio-economic groups, but the burden of obesity has shifted towards the lower socio-economic groups.[6] There is also accumulating evidence to support the idea that poverty and food insecurity are paradoxically linked to overnutrition.[7] Intake of a less diversified and energy dense diet has been

implicated in this complex relationship of poverty, food insecurity and over-nutrition.

Conventionally, under-nutrition and over-nutrition have been treated as distinct health problems, each with its own underlying factors. However, with changes in the dietary patterns and lifestyles of populations in developing countries, the co-existence of under-nutrition and over-nutrition within countries, communities and households has become inevitable.[8-13] The occurrence of both types of malnutrition, particularly in the same households with adults and children being obese and underweight respectively, dictates that similar factors may underlie these two health problems.

Dietary diversity or variety is a simple count of food items or food groups consumed by households or individuals over a certain time period.[14] It is recognized as a

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key component of healthy diets as consuming a wide variety of foods will ensure improved intakes of nutrient and non-nutrients that are associated with reduced mortality and risk of chronic diseases.[15-17] However, for households with limited economic resources, obtaining a balanced and adequate diet can be a challenge, especially when lower nutrient-dense foods that are higher in fat and carbohydrate are less expensive compared to healthy food choices (i.e. fruits, vegetables, lean meats, whole-grains, low-fat products). Thus, dietary diversity could be a common determinant for the coexistence of under- and over-nutrition in these impoverished households.

Indigenous peoples are social groups characterized by occupation within defined ancestral territories, maintenance of cultural, social, economic and political institutions within the territories that are distinct from those of the dominant societies and self identification with the tribal groups.[18] In countries undergoing epidemiological and socio-economic transitions, the indigenous peoples are not spared from being affected by nutrition transition, which is characterized by the shift from the consumption of varied traditional diets to diets that are increasingly dependent on processed foods, high in saturated fat and sugar but low in fiber.[19] The transition to a westernized dietary patterns and lifestyle has brought about changes in the disease patterns of the indigenous peoples, from those of communicable to non-communicable diseases.[20] While nutritional deficiencies are still prevalent among the children of the indigenous groups,[21, 22] nutrition-related non-communicable diseases are becoming prevalent in the adult population.[23,24]

The Orang Asli is the indigenous people of Peninsular Malaysia and comprises three main ethno-linguistic groups, namely the Negrito, Senoi, and Proto-Malay, each with diverse cultures and languages.[25] In comparison to the mainstream ethnic groups in Malaysia, the Orang Asli is a socio-economically disadvantaged population.[26] Studies on the Orang Asli children showed that energy and nutrient deficiencies as well as inadequate growth attainment are still prevalent.[27-29] While chronic energy deficiency persists among the Orang Asli adults, there are however, studies that show that overweight and obesity are on the rise.[30-32] As increasing evidences in many indigenous communities worldwide indicate the co-existence of both undernutrition in children and overnutrition in adults, and such evidence is not available for the Orang Asli in Malaysia, this study was conducted to identify the presence of the dual burden of malnutrition in the same households in the Orang Asli communities and the factors underlying both forms of malnutrition.

## MATERIAL AND METHODS
This was a cross-sectional study conducted from 2002 to 2005 in 14 Orang Asli villages in Selangor, a state located in the central region of Peninsular Malaysia. The Sepang District (9 villages) and Carey Island (5 villages) were the two locations selected for their high number of Orang Asli households of two major Orang Asli sub-ethnic groups in Selangor. The Temuan, a sub-ethnic of Proto-Malay, resided in the Sepang District, while the Mahmeri of the Senoi ethnic group were the only Orang Asli communities on Carey Island. Both the Temuan and Mahmeri

communities could be accessed by cars as Sepang District and Carey Island are about 40 km and 80 km, respectively from Kuala Lumpur, the capital of Malaysia. Altogether, there were 189 Temuan households in the 9 villages and 230 households in the Mahmeri villages. The Mahmeri and Temuan were relocated to these villages to make way for highway and housing development as well as rubber and oil palm plantations.

Prior to data collection, permission to carry out the study was obtained from the Department of Aboriginal Affairs (JHEOA). Visits were arranged by the JHEOA officers to seek cooperation from the Tok Batin (village headmen). The research protocol was approved by the Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. Subjects who consented to participate in the study were required to sign or initialize the consent form, which was read to each subject (mother) by the researchers with the assistance of either the JHEOA officer or Orang Asli from the community.

### Subjects
All of the 339 households in both locations were screened for the presence of mother-child pairs that met the study's inclusion and exclusion criteria of at least one child aged 2-9 years-old with no health disabilities and a non-pregnant mother in the age group of 18 to 55 years. A total of 227 households met these criteria; however, only 182 households were willing to participate in the study. If a household had more than one child in each age group, the youngest child was selected.

### Measurements
Individual interviews with the mothers and measurements of the weight and height of the children and mothers were carried out in the home of the participants. A pre-tested questionnaire was used for the interview and it consisted of items on household demographic and socio-economic characteristics as well as dietary intake of the selected mother-child pair.

### Demographic and socioeconomic information
Mothers were interviewed for information such as income, household size, number of children, children's particulars (age, gender, and education level), parental age, education and occupation. Provision of children's birth certificates by mothers facilitated the recording of children's age. In several cases fathers were interviewed by the researchers when the needed information could not be obtained from the mothers (e.g. household income and parental education).

### Anthropometry
Weight and height measurements of the children and mothers were taken using Tanita (Tanita Corporation, Tokyo, Japan) digital weighing scale to the nearest 0.1 kg and Seca body meter (Vogel and Halke Gmgh & Co., Hamburg, Germany) with a precision of 0.1 cm, respectively. The age of the child was calculated in months from the date of birth to the date of data collection. Weight-for-age, height-for-age and weight-for-height were the three indicators calculated from weight and height measure-

ment and expressed in terms of z-scores using ANTHRO software. For children aged 1-5 years old, the three indicators (WAZ, HAZ, and WHZ) were compared to the WHO growth standards while NCHS/WHO reference data was utilized for the older children (> 5 years old).[33, 34] Underweight and stunting were defined as WAZ, HAZ and WHZ below -2 standard deviation (SD). Weight and height measurements of mothers were transformed into Body Mass Index (BMI) and cut-offs used for underweight and overweight were BMI < 18.5 kg/m² and BMI ≥ 25.0 kg/m², respectively.[35] All households were examined for possible categories in terms of nutritional status of mother child pair, namely overweight mother/underweight child (OW/UW), normal weight mother/normal weight child (NW/NW), overweight mother/normal weight child (OW/NW), normal weight mother/underweight child (NW/UW) and underweight mother/normal weight child (UW/NW). This study only considered two types of nutritional status combinations: 1) Overweight mother/ underweight child pair (OW/UW) – mother's BMI ≥ 25.0 kg/m² and child's WAZ < -2 SD; Others (OT) – all mother-child pairs except OW/UW. The rationale for having these combinations is that more resources are needed to address households with double burden of malnutrition than households with no malnutrition or only one type of malnutrition (overweight or underweight).

**Dietary intake**
Three days (2 weekdays and a weekend day) of dietary intake information were obtained from both mother and child using the 24-hour diet recall method. The food intake data were used to determine energy intake and the food variety score. Mothers were guided by the researchers to estimate foods consumed by themselves and their children using common household measurements (e.g. spoons, bowls, plates, cups and glasses). Food intake data were analyzed for energy using Nutritionist Pro 2.5 (First Databank, USA). The average of the three-day intakes for energy was determined and compared to the Malaysian Recommended Nutrient Intake (RNI) for assessing energy adequacy.[36]

Food variety was measured as the total number of food items consumed over a 3 day period, from a possible total of 69 food items consumed by all mothers and children in this study identified from the three 24 hour diet recalls. In these Temuan and Mahmeri communities, most of the foods consumed by the adults are also eaten by the children and the practice of giving adult foods (e.g. rice, banana, tapioca, pancake, crackers, fish, egg) to the children can start as early as when the child is 3 months-old. As these Orang Asli communities are living near the town areas, they are less dependent on foods from the forest, river and sea. Almost all the foods consumed by them are available at the markets and similar to those consumed by the major ethnic groups (Malay, Chinese and Indian).

The 69 food items (Table 1) comprised of foods from grains and cereals (15), fruits (5), vegetables (18), milk and dairy products (4) and meat/poultry/egg (4), fish and seafood (23). We did not include palm oil, coconut milk, sugar, salt, seasonings, soy sauce, ketchup (tomato and chili) in the food item list as these food items are commonly added to the cooked foods and hot beverages (tea or coffee) or used in food preparation (e.g. palm oil for frying). In addition, the intake of 'processed' and/or 'high energy-dense foods' could be represented by the consumption of traditional pancake and unleavened bread (roti canai) (white flour and oil), traditional cakes (rice/glutinous/wheat flour) and foods that are prepared using deep-fry method or ingredients such as coconut milk. The traditional cakes can also be high in sugar and/or fat as many are deep-fried or mixed with coconut milk and sugar. Other processed foods include instant noodles, crackers, bread and buns. The consumption of biscuits refer mainly to the cream-crackers and soda crackers and very few consumed wafers, cream biscuits, sugared crackers or cookies as these are more expensive than the crackers. As only the minority of the women and children consumed these relatively expensive biscuits, we combined these into the cracker/biscuit group. If the food item was consumed at least once over the 3 day period, a score of 1 was given.

**Statistical Analysis**
Data were analyzed using the Statistical Package for So-

**Table 1.** List of foods[†] consumed by Orang Asli women and children

| Food groups | Food items |
| --- | --- |
| Grain and cereals | Rice/rice porridge, wet noodles, rice vermicelli, instant noodles, traditional pancake, white bread, filled bun, unleavened bread (roti canai), corn, crackers/biscuits, tapioca, sweet potato, yam, potato, traditional cakes |
| Fish | Sardine, dried fish, anchovies, tilapia (*Tilapia mossambica*), tenggiri (*Scomberomorus guttatus*), selar kuning (*Selaroides leptolepis*), lampam jawa (*Puntius gonionotus*), kembong (*Rastrelliger kanagurta*), keli (*Clarias batrachu*), belanak (*Valamugil seheli*), selar (*Selar (Atule) mate*), selangat (*Anodontostoma chacunda*), snakehead, gelama (*Johnius (Preudosciaena) soldado*), semilang (*Plotosus canius*), puyu (*Anabas testudineus*), senangin (*Eleutheronema tetradactylum*) |
| Seafood | Squid, prawn, crab, cockles, mussels, lokan (*Polymesoda expansa*) |
| Meat | Beef, chicken, egg, pork |
| Vegetables | Cabbage, french bean, brinjal, mushroom, bean sprouts, cucumber, tapioca shoots, long bean, pumpkin, mustard, okra, sweet potato shoots, fern shoots, spinach, bamboo shoots, swamp cabbage, cemperai (*Champereia griffithii*), cekur manis (*Sauropus androgynus*) |
| Fruits | papaya, starfruit, pineapple, watermelon, banana |
| Milk | chocolate milk (UHT), powdered full cream milk, soy milk, sweet condensed milk |

[†]foods are based on 3 days of 24 hour diet recall

**Table 2.** Sample characteristics (n=182)

| Factors | M (SD) | n (%) |
|---|---|---|
| Demographic and Socioeconomic | | |
| Ethnicity | | |
|    Mahmeri | | 99 (54.4) |
|    Temuan | | 83 (45.6) |
| Mother's age (years) | 30.8 (7.8) | |
| Mother's education (years) | 6.2 (2.5) | |
| Mother's employment status | | |
|    Working | | 45 (24.7) |
|    Housewife | | 137 (75.3) |
| Household income (RM$^{†}$) | 684 (550) | |
| Household size | 5.7 (2.0) | |
| Income per capita (RM$^{†}$) | 129 (96.9) | |
| Number of children | 3.4 (1.9) | |
| Child's age (years) | 4.5 (2.6) | |
| Child's sex | | |
|    Male | | 96 (52.7) |
|    Female | | 86 (47.3) |
| Mother's Nutritional Status | | |
|    Weight (kg) | 57.8 (14.9) | |
|    Height (m) | 1.6 (1.1) | |
| Body mass index (kg/m$^2$) | 25.9 (5.2) | |
|    <18.5 | | 11 (6.0) |
|    18.5 – 24.9 | | 78 (42.9) |
|    25.0 – 29.9 | | 57 (31.3) |
|    > 30 | | 36 (19.8) |
| Energy intake (kcal) | 1395 (673) | |
| Food Variety Score (FVS) | 7.0 (2.1) | |
| Children's Nutritional Status | | |
|    Weight (kg) | 17.0 (14.0) | |
|    Height (cm) | 98.4 (17.1) | |
| Weight-for-age | -1.8 (1.0) | |
|    < - 2SD | | 106 (58.3) |
|    > - 2SD | | 76 (41.8) |
| Height-for-age | -2.1 (1.5) | |
|    < - 2SD | | 117 (64.3) |
|    > - 2SD | | 65 (35.7) |
| Energy intake (kcal) | 980 (512) | |
| Food Variety Score (FVS) | 6.9 (1.9) | |
| Classification of households (mother-child pair) | | |
| Overweight mother/underweight child (OWM/UWC) | | 47 (25.8) |
| Normal weight mother/normal weight child (NWM/NWC) | | 27 (14.8) |
| Overweight mother/normal weight child (OWM/NWC) | | 46 (25.3) |
| Normal weight mother/underweight child (NWM/UWC) | | 58 (31.9) |
| Underweight mother/normal weight child (UWM/NWC) | | 4 (2.2) |

$^{†}$1 USD = RM3.3

cial Sciences (SPSS, version 14.0). All variables were presented descriptively as mean, standard deviation and frequency. T-test and Chi-square tests were carried out to compare factors between dual burden (OW/UW) and other (NW/NW, OW/NW, NW/UW, UW/NW) households. Univariate and multivariate logistic regressions were then utilized to identify factors associated with dual burden of malnutrition. Statistical significance was set at $p<0.05$.

**RESULTS**
*Sociodemographic characteristics*
Demographic and socioeconomic characteristics of the 182 Orang Asli households (54.4% Mahmeri and 45.6% Temuan) are presented in Table 2. The mean age of the women was 30.8±7.8 years and ranged from 17 to 49 years. In general, the educational level of the mothers

was low (6.2±2.5 years), with half (50.5%) only receiving primary education and 28.0% never had any formal education. Although most of the women were housewives (75.3%); they sometimes grow vegetables, gather wild vegetables and fish at the river or sea; and help their spouses in the rubber and palm oil plantations. The mean monthly household income (RM 684±549) was lower than the poverty line income of Malaysia (RM691) with almost half of the households living below the poverty line. The children comprised of 96 (52.7%) males and 86 (47.3%) females. The mean age of the children was 4.5±2.6 years and ranged from 1.2 to 8.5 years.

*Nutritional status*
About 31% and 20% of the women were overweight and obese, respectively (Table 1). Among the children, more

**Table 3.** Nutritional status and food variety score (FVS) of mothers and children

| Factor | OT[†] (n=135) | OW/UW[‡] (n=47) | *p*-value | Crude Odd ratio (95% CI[§]) | Adjusted Odd ratio (95% CI[§]) |
|---|---|---|---|---|---|
| Ethnicity | | | 0.88[¶] | 1.05 (0.54, 2.05) | 1.07 (0.5, 2.29) |
|   Mahmeri | 73 (54.1) | 26 (55.3) | | | |
|   Temuan | 62 (45.9) | 21 (44.7) | | | |
| Mother's age (years) | 30.8 (8.0) | 30.7 (7.1) | 0.93[††] | 0.99 (0.96, 1.04) | 0.95 (0.89, 1.02) |
| Mother's education (years) | 6.3 (2.4) | 6.1 (2.5) | 0.69[††] | 0.97 (0.88, 1.07) | 1.00 (0.89, 1.12) |
| Mother's employment status | | | 0.03[¶] | 2.78 (1.09, 7.06)* | 3.18 (2.65, 5.66)* |
|   Working | 39 (28.9) | 6 (12.8) | | | |
|   Housewife | 96 (71.1) | 41 (87.2) | | | |
| Household income (RM) | 700.2 (543.3) | 640.9 (565.0) | 0.53[††] | 0.99 (0.99, 1.00) | 1.00 (0.99, 1.00) |
| Household size | 5.5 (2.1) | 6.0 (1.9) | 0.18[††] | 0.77 (0.52, 1.16) | 0.75 (0.45, 1.27) |
| Income per capita (RM) | 136.9 (99.9) | 113.2 (88.1) | 0.15[††] | 0.99 (0.98, 1.00) | 0.99 (0.98, 1.01) |
| Number of children | 3.1 (1.9) | 3.9 (1.9) | 0.02[††]* | 1.22 (1.03, 1.45)* | 1.37 (0.53, 3.53) |
| Child's age (years) | 4.5 (2.6) | 4.4 (2.7) | 0.85[††] | 0.98 (0.87, 1.12) | 0.97 (0.82, 1.14) |
| Child's sex | | | 0.34[¶] | 0.73 (0.37, 1.41) | 0.70 (0.33, 1.49) |
|   Male | 74 (54.8) | 22 (46.8) | | | |
|   Female | 61 (45.2) | 25 (53.2) | | | |
| Mother's energy intake (kcal) | 1425 (722) | 1308 (509) | 0.31[††] | 1.00 (0.99, 1.01) | 1.00 (0.99, 1.00) |
| Mother's FVS | 7.0 (2.0) | 7.1 (2.2) | 0.09[††] | 1.36 (1.03, 1.81)* | 1.39 (1.02-1.89)* |
| Child's energy intake (kcal) | 1032 (529) | 833 (394) | 0.02[††]* | 0.99 (0.98, 1.00) | 0.99 (0.99, 100) |
| Child's FVS | 7.3 (2.1) | 6.6 (1.7) | 0.03[††]* | 0.72 (0.53, 0.96)* | 0.71 (0.51-0.95)* |

[†]OT (Other households); [‡]OW/UW (overweight mother/underweight child)
[§]CI (Confidence Interval)
[¶]Chi-square analysis; [††]T-test analysis
* Significantly different at *p* < 0.05

**Table 4.** Energy intake and nutritional status of mothers and children by food variety score (FVS)

| | Food Variety Score (FVS) | | |
|---|---|---|---|
| | 1st tertile (0-6) | 2nd tertile (7-8) | 3rd tertile (>9) |
| Mothers | (n=77) | (n=57) | (n=48) |
| Energy intake (kcal) (M+ SD) | 1282 (589)** | 1326 (545)* | 1672 (859)*, ** |
| Overweight and obese (%) | 48.7 | 53.7 | 55.6 |
| Children | (n=68) | (n=69) | (n=45) |
| Energy intake (kcal) (M+SD) | 883 (512)* | 984 (515) | 1132 (477)* |
| Underweight (%) | 61.8 | 63.8 | 43.6 |

*   Significantly different at *p* < 0.05
** Significantly different at *p* < 0.01

than half were underweight (58.3%) and stunted (64.3%). None of the children were overweight. Based on the 3 days of diet recall, the mean energy intake of the women and children were 1395±673 kcal and 980±512 kcal, respectively. The mean Food Variety Score (FVS) was similar for women (7.0±2.1) and children (6.9±1.9). The similarity in foods consumed by mothers and children was further confirmed by the significant correlation between the FVS of mothers and children (r=0.78, *p*<0.001). The number of food items consumed by both mothers and children over the 3 day period ranged from 2 to 13, indicating a diet with little variety. The most prevalent household type was normal weight mother/underweight child (31.9%), followed by overweight mother/underweight child (25.8%), overweight mother/normal weight child (25.3%), normal weight mother/normal weight child (14.8%) and underweight mother/normal weight child (2.2%). In this sample of Orang Asli, there were no households with underweight mother/underweight child.

***Factors associated with dual burden of malnutrition***
In examining the factors associated with households experiencing dual burden of malnutrition, all households except for households with OW/UW, were collapsed into other (OT) households. Table 3 presents the comparison of demographic, socioeconomic and nutritional factors between OW/UW and OT households and the crude and adjusted OR and 95% CI for factors associated with dual burden households. Compared to OT households, OW/UW households had a significantly higher proportion of housewives ($\chi^2$=4.87, *p*<0.05), mean number of children (t=2.41, *p*<0.05) and children with higher mean energy intake (t=2.29, *p*<0.05) and FVS (t=3.31, *p*<0.05). Based on univariate logistic regression, women's employment status (OR: 2.78, 95% CI: 1.09-7.06), FVS of children (OR: 0.72, 95% CI: 0.53-0.96), FVS of women (OR: 1.36, 95% CI: 1.03-1.81) and number of children (OR: 1.22, 95% CI: 1.03-1.45) were associated with dual burden households. However, after adjusting for potential con-

founding factors, only 3 factors remained significantly associated with dual burden households – Women with higher FVS and being housewives were 1.39 times and 3.18 times more likely to be associated with OW/UW households compared to OT households, respectively; children with higher FVS were 0.71 times less likely to be associated with OW/UW households. A separate logistic regression analysis was conducted with only the OW/UW (n=47) and NW/NW (n=27) to confirm the association of these three factors with dual burden households (data are not shown). In the analysis, all of these factors (mother's employment status, child's FVS and mother's FVS) remained significantly associated with dual burden households.

To further verify the associations between food variety scores of mothers and children and household types (OW/UW, OW/NW, NW/UW), we conducted three separate logistic regressions (data not shown). Food variety score of mothers (adj. OR: 1.92, 95% CI: 1.64-2.77) and children (adj. OR: 0.49, 95% CI: 0.25-0.89) showed significant associations with OW/UW households (compared to the reference households (NW/NW)), while none was observed for OW/NW (mother – adj. OR: 1.39, 95% CI: 0.86-2.24; children – adj. OR: 0.79, 95% CI: 0.49-1.27) and NW/UW (mother – adj. OR: -1.25, 95% CI: 0.82-1.91; children – adj. OR: 0.80, 95% CI: 0.52-1.23).

Energy intake and weight status of mothers and children were found to be associated with the food variety score. The mean energy intake of both mothers and children significantly increased as FVS increased (Table 3). While the percentages of overweight/obese mothers increased with FVS tertiles, the percentages of underweight children decreased with FVS tertiles. However, none of the association between FVS with underweight and overweight/obesity was significant.

## DISCUSSION

The coexistence of undernutrition and overweight has been found to be prevalent in several developing countries, especially countries in the middle ranges of per capita GNP. In Vietnam, China, Kyrgyzstan, Indonesia, Russia, Brazil and United States, 3-16% of the households contained both underweight and overweight members.[9] A household with an underweight or stunted child and overweight or obese adult is the typical dual burden household for developing countries undergoing rapid transition. Based on large national surveys, the co-existence of underweight child and overweight non-elderly adult was found to be the most prevalent combination of underweight and overweight household type in China (39%), Brazil (59%) and Russia (62%).[13]

Other recent studies have focused on household phenotype of underweight or stunted child and overweight or obese mother. Using the Health and Demographic Surveys (DHS), Garrett and Ruel showed that 3% of Asian-, 4% of African- and 7% of Latin American households contained the stunted child-overweight mother pair.[12] In Malaysia, Khor and Zalilah reported the coexistence of the underweight child and overweight mother pair in 26% of 140 rural households while households with normal child-mother pair consisting 19.7% of the study population.[37] In a sample of 203 urban households in Haiti, underweight child-overweight mother pairs were found in 14.3% of the households while the common household phenotype was underweight child-normal weight mother (36%).[10] A study in Manila showed a lower percentage of households with underweight child-overweight mother pair (8.2%) but highest percentage with normal child-normal mother pair (41%).[38] While it was thought that the co-existence of child undernutrition and maternal overweight or obesity is less common in African countries, a study in poor urban neighborhoods of Benin (West Africa) found that the proportion of households with this phenotype was 16.2%.[39]

In this study, the proportion of Orang Asli households with the underweight child-overweight mother pair (25.8%) was much higher than the percentages reported in previous studies.[10,37-39] This finding could be attributed to the high percentages of underweight children (58%) and overweight mothers (51%). Undernutrition was once predominant in both Orang Asli children and adults and perhaps it is still a major health concern among those living in the interior parts of Peninsular Malaysia. However, in this sample of semi-urbanized Orang Asli, underweight and overweight are becoming equally important. Living near urban areas, their dependence on forest resources for food and economy have reduced, which could contribute to changes in dietary intake and their physical activity level. A shift from their traditional food sources generally means a decrease in the consumption of wild animals, fish, cultivated agricultural crops and wild plant foods with a simultaneous increase in intakes of processed foods which are high in fat, sugar and salt.[40] Dietary changes are also accompanied by reduced physical activity due to the shift from hunting and gathering activities to sedentary daily activities and occupations.[41]

Dietary intake and physical activity changes experienced by the Orang Asli could lead to different nutritional consequences for adults and children. For the Orang Asli women, increased physical inactivity and intakes of refined carbohydrate, sugar, meat and fat and reduced dependence on indigenous foods appear to have contributed to overweight and obesity. Indigenous foods that are characterized by high complex carbohydrate, fruits, vegetables and a variety of plants are not only rich in nutrients but also non-nutrient components that may confer health benefits. For the physically active Orang Asli children, the consumption of foods such as fried bananas and flour fritters, pancakes, boiled tapiocas, plain rice gruel and rice with limited intakes from meat, milk, fruit and vegetable groups could have an adverse impact on growth attainment.[29] As the children may not eat as much as the adults, the diet may be insufficient in both energy and micronutrients to meet the children's nutritional requirement. Consequently, the chronic energy and nutrient inadequacy due to limited amount and variety of foods consumed could compromise the growth and development of the children.

Numerous studies have shown that dietary diversity is positively associated with measures of dietary quality or nutrient adequacy in both adults and children.[42-46] However, its positive association with nutrient adequacy is only to a certain extent in that when nutrient requirements are met, increasing food variety is often accompanied by

excess calories without additional health benefits.[47] Ponce and co-workers reported that Mexican men with highly diversified diets were more likely to meet their micronutrient needs but the diets were less in accordance with the World Health Organization recommendations to prevent chronic diseases.[48] These men had significantly higher intakes of cholesterol and percentage of energy from fat and saturated fat. In a study among 71 American men and women,[49] a high diet variety especially derived from high-fat and high-calorie commercial foods was associated with increased energy intakes and accumulation of body fat. These findings suggest that increased availability and variety in food choices especially in the context of energy-dense foods that are high in fat, refined sugar and salt may contribute to the development and maintenance of obesity.

In this study, a higher food variety score for women was found to be associated with the risk of dual burden households and that the percentage of overweight and obese women increased across the tertile categories of the food variety score. However, the association between dietary diversity or food variety score and weight status in adults as reported in the literature has been somewhat inconsistent. Several studies have reported that higher dietary diversity is associated with increased risk of adult overweight and obesity.[48-50] In a study among women of child bearing age in Burkino Fasa, the more diversified the diets, the better the nutritional status (BMI and percentage of body fat) of the women.[44] The proportion of underweight women was much higher in the lower dietary scores (22.8%) category compared to the medium (7.3%) and high (9.8%) categories. Torheim and colleagues however did not find any significant association between BMI status and food variety score of dietary diversity score among male and female adult population (15-45 years old) in Mali.[43] The inconsistent relationship between dietary diversity or food variety and weight status in adults could be due to factors such as homogeneity of weight status and dietary diversity scores, the stability of the adults' weight status compared to that of children, various approaches in measuring dietary diversity as well as differences in socio-economic background of the study subjects.

Despite different methodological approaches and study populations, positive association between dietary diversity and child nutritional status has been observed in most studies. Arimond and Ruel documented significant associations between dietary diversity and height-for-age z scores among children aged 6-23 months old independent of socioeconomic status in all but 1 of the countries studied.[51] The study also reported that the association was stronger in children who were no longer breast-fed, indicating the importance of dietary diversity for non-breast-fed children relying on complementary foods for energy and nutrient needs. Other studies have shown that the positive association between dietary diversity and nutritional outcomes is extended beyond 2 years of age. Hatloy and colleagues reported that urban children aged 6-59 months with lower dietary diversity scores had a higher risk of being stunted and underweight.[42] Based on nationally representative data of 1-8 year-old children in South Africa, dietary diversity scores and food variety scores were also found to be significantly associated with weight-for-age and height-for-age z scores.[45]

This study also found an association between mother's employment status and dual burden households. Compared to the other household types (71.1%), dual burden households had significantly higher proportion (87.2%) of non-working mothers or housewives. Non-working women or housewives may not be physically active and have low energy expenditure compared to working or employed mothers.[52] Working mothers may not only work in strenuous occupations or have multiple jobs but also undertake the burden of housework. A study in Iran reported that housewives were more likely than the employed mothers to be in the obese group and the authors suggested that this could be due to engagement in less physically active domestic duties and frequent access to food at homes.[53] From our observations, the common home activities of non-working Orang Asli women were child care (e.g. putting the children to sleep, feeding the children, watching the children play), household chores (e.g. cooking, sweeping the floor, washing clothes and dishes), weaving mats or making brooms and visiting neighbors. Activities such as gathering of wild vegetables, cockles and mussels, and helping their spouses in rubber and palm oil plantations were done on irregular basis, depending on the daily weather and monsoon season. Having many children has also been shown to be positively associated with weight gain, especially among housewives or non-working women. These housewives caring for large families could have gained weight due to a combination of increased food intake and reduced physical activity as well as lack of exposure to healthy behaviors or they have little time to practice healthy behaviors that promote weight loss.[54]

Employment of women has been shown to have positive effects on the health and nutrition status of children. Women's employment increases household income which eventually could benefit household nutrition. Households of working mothers usually have greater food expenditures and also higher levels of food sufficiency.[55] Moe and co-workers showed that working mothers were able to provide quality diet for their children as they have more purchasing power to choose and prepare healthy foods which were relatively more expensive than low quality or less healthy food.[56] With better quality and quantity foods, the children are able to meet energy and nutrient requirements and attain better health and nutritional status.

This study is not without limitations. First, we used cross-sectional data to identify factors associated with dual burden households which did not allow us to determine cause and effect relationship. Nevertheless, this is an initial step to understand such association in indigenous peoples undergoing nutrition transition. Future studies that employ a prospective or case-control design are required to confirm this association. Second, comparisons were made only between dual burden households and a combination of other phenotype households. The comparisons may not reflect the actual differences between dual burden and reference households (normal mother/ normal child). However, the association between food variety score and dual burden household persisted even when the analysis was done only for dual burden and ref-

erence households. Third, the FVS was constructed from food items consumed over a 3 day-period and the food consumption data were obtained through 24-hour diet recalls. As with other dietary methods, dietary recall has its own limitations that may influence the validity of the FVS. For example, under-reporting of food items due to poor memory or embarrassment could influence the reported food and consequently energy intake. In this sample of Orang Asli women, using an EI/BMR ratio of < 1.2, about 52.8% were considered as under-reporters.[57] This high percentage of under-reporting was found despite various efforts (e.g. the use of food pictures and familiar household utensils, trained enumerators) to assist the women to recall and estimate their food and fluid intakes. Another limitation of the FVS is the exclusion of fats/oils (e.g. palm oil and coconut milk) and sugar in the food item list. However, these food items could be represented by other foods consumed such as fish/meat/egg (which are commonly fried or cooked in gravy), traditional cakes and pancake, unleavened bread (roti canai) and sweetened condensed milk. As the FVS was based on 24 hour diet recalls, the time of the survey could influence the types of seasonal foods consumed by the Orang Asli. For example, although most of the fruits consumed by these Orang Asli communities are non-seasonal and grown by themselves, there are also seasonal fruits that are planted in their house compounds. However, during the survey, most of these fruits were not in season. Although this study found that the FVS is a useful tool, further validation studies are needed. Fourth, there are many factors that contribute to child undernutrition and adult overweight or obesity which could also be the underlying causes of undernutrition and overweight within the same households. For example, stunting in childhood which is prevalent in marginalized populations is associated with increased risk of obesity in adulthood.[58] In these Orang Asli communities, the high prevalence of stunting in children could predispose them to be overweight or obese as adults. This study also did not examine factors such as family relationship or mother-child interaction, physical activity patterns, psychological well-being and intra-household food allocation which could be important determinants of dual burden households. More in-depth studies should be carried out to explore other factors that may contribute to dual burden households in Orang Asli population. Finally, this study only examined mother-child pair and not other combinations comprising other adults or older children (> 9 years). These exclusions may influence the presentation of dual burden malnutrition within the same households.

## CONCLUSION
In this study, while undernutrition (underweight and stunting) remained a major health problem among Orang Asli children, a high proportion of the Orang Asli women were overweight and obese. The high percentage of dual burden households in these Orang Asli communities underscores the importance of undernutrition as underweight or stunted children may be predisposed to becoming overweight or obese adults. Simultaneous efforts to prevent child undernutrition and adult obesity are required to address dual burden households. However, any intervention targeting at-risk individuals within the

households must consider all other household members i.e. focusing on prevention of adult obesity could compromise the nutritional status of children in the same household. Promoting consumption of a variety of foods or dietary diversity within healthy food groups together with healthy lifestyle should be incorporated into intervention programs for dual burden households as these health messages could contribute to optimal weight and well-being of all household members.

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Original Article

# Food variety score is associated with dual burden of malnutrition in *Orang Asli* (Malaysian indigenous peoples) households: implications for health promotion

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## 食物多樣性分數與馬來西亞原住民家庭的兩極化營養不良相關：健康促進的建議

此篇報告是關於馬來西亞原住民社群中，有兩極化營養不良家庭的現象及其相關因子。在雪蘭莪省的兩個區域，共有 182 原住民家庭參加此研究(182 位育齡但未懷孕的婦女及 284 位 2-9 歲兒童)。測量婦女及兒童的身高和體重。並使用三次 24 小時回憶問卷評量能量攝取及食物多樣性分數(FVS)。婦女過重及肥胖盛行率分別為 31%及 20%，但有 58%的兒童體重過輕及 67%的兒童生長遲緩。兩極化營養不良家庭(母親過重/兒童過輕)比例為 25.8%；而 14.8%的家庭中，母親及兒童體重都在正常範圍。母親(7.0±2.1)及孩童(6.9±1.9)有相似的食物多樣性分數（FVS）平均值。家庭兩極化營養不良分別與母親就業情形(OR: 3.18, 95% CI: 2.56-5.66)、兒童 FVS(OR: 0.71, 95% CI: 0.51-0.95) 及母親 FVS(OR: 1.39, 95% CI: 1.02-1.89)有相互關聯。將兩極化營養不良家庭僅與兒童及母親體重正常的家庭相比，兒童及母親 FVS 仍有顯著關聯(OR: 0.49, 95%CI: 0.25-0.89; OR: 1.92, 95% CI: 1.64-2.77)。在原住民社區，食物多樣性或可用來預測兒童飲食健康；但在成人反而增加過重或肥胖危險性。努力解決兩極化營養不良家庭時，需考慮促進各成員健康飲食及生活型態。

關鍵字：原住民、兩極化營養不良、食物多樣性、體重過重、體重過輕