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# Dietary Diversity Is Associated with Nutritional Status of Orang Asli Children in Krau Wildlife Reserve, Pahang

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## ABSTRACT

**Introduction:** It is known that dietary diversity improves diet quality and nutritional status of young children. This study aimed to determine the relationship between dietary diversity and nutritional status of Orang Asli children in Krau Wildlife Reserve. **Methods:** A total of 216 children from three Orang Asli sub-tribes (Jah Hut, Temuan and Che Wong) aged 1 to 6 years from 162 households in 16 villages participated in this cross-sectional study. Children and mothers were measured for body weight and height. Mothers were interviewed for household socio-demographic information and diet diversity of children in the last 7 days. Diet diversity score (DDS) was calculated based on 15 food groups. **Results:** There was a high prevalence of underweight (50.9%) and stunting (61.6%) in Orang Asli children. For mothers, 11.1%, 27.8% and 7.4% were underweight, overweight and obese, respectively. Mean DDS of children was 6.38 [95% CI-6.10, 6.65] of the possible 15. Higher DDS of children was significantly related to older age ($p<0.05$), the non Jahut sub-tribe ($p<0.01$) and longer maternal years of schooling ($p<0.05$). DDS was also positively related to weight-for-age z-scores ($p<0.001$) and height-for-age z-scores ($p<0.05$). **Conclusion:** Undernutrition remains a major nutrition problem among Orang Asli children living within the forest reserve. Efforts to promote dietary diversity should emphasise traditional and nutritious foods that could improve health and nutritional status of the Orang Asli children.

**Keywords:** Dietary diversity, growth, Krau Wildlife Reserve Orang Asli, preschoolers

## INTRODUCTION

Despite the global decline in the prevalence of underweight from 1990 to 2010, one out of four children under 5 years in developing countries is undernourished (United Nations, 2011). The global burden of stunting still persists with one-third of children less than 5 years in the developing world being stunted (UNICEF, 2009). High levels of undernutrition have significant adverse consequences on child survival, growth and development (Black *et al*., 2008). Stunting is associated with cognitive impairment among children (Grantham-McGregor *et al.*, 2007) and higher risk of

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obesity in later life (Hoffman *et al.*, 2000). Poverty is the main determinant of disparities in nutritional status among young children (Pongou, Ezzati & Salomon, 2006). Young children from the poorest households in developing countries are about twice as likely to be underweight and stunted compared to their counterparts from the richest households (United Nations, 2011).

Indigenous peoples in many countries continue to be among the poorest and the most marginalised groups with poor health and social outcomes. Health deprivation occurs at each stage of the life cycle among the indigenous population. The prevalence of undernutrition is 2-3 times higher in indigenous than in non-indigenous children (Rivera, Irizarry & Gonzalez de Cossio, 2009). In youth and adult population, smoking and alcoholism are prevalent (Burke *et al.*, 2007) and concurrent with changes in dietary and physical activity patterns; these lifestyle behaviours put the indigenous population at higher risk of obesity (Garriguet, 2008) and diet related chronic diseases such as type 2 diabetes and cardiovascular diseases (McDermott, Li & Campbell, 2010).

The term 'Orang Asli' refers to the indigenous peoples or the first people of Peninsular Malaysia (Chupil & Joseph, 2003). In 2004, a total of 149, 723 Orang Asli, contributing to 0.6% of the national population, were living in 869 villages predominantly located in the states of Pahang and Perak (JHEOA, 2006). The Orang Asli are divided into three main tribes which are Negrito, Senoi, and Proto-Malays who are further classified into 18 sub-tribes. The population is not homogeneous as they have a diverse socio-cultural life in terms of traditions, beliefs, and languages, depending on their tribal groups and living locations.

Orang Asli households still remain poor despite government poverty reduction strategies to improve the livelihood of this indigenous population. The incidence of poverty among Orang Asli communities was 50% in 2009 (Economic Planning Unit, 2010). As most of the Orang Asli live below the poverty line, the prevalence of undernutrition, both underweight and stunting, among the children is higher than the national average. The national prevalence of undernutrition was 16 - 20% in children aged 1-6 years (Institute of Public Health, 2008). In contrast, previous studies have reported undernutrition to range from 45 - 52% in Orang Asli children within the same age group (Zalilah & Tham, 2002; Wan Norlida *et al*., 2007)

Consumption of quality diet is essential for growth and development as inadequate intake of energy and nutrients is a primary cause of child undernutrition (Allen, 2006). Diet quality can be reflected by dietary diversity which is defined as the number of different food groups consumed over a given reference period (Ruel, 2003). Studies have shown that dietary diversity is positively correlated with the intake of energy and nutrients (Torheim *et al*., 2004) and growth of children (Arimond & Ruel, 2004).

For indigenous peoples, particularly in rural areas, less dependence on traditionally harvested food and more reliance on market food have contributed to a decrease in diversity of food consumed (Damman, Eide & Kuhnlein, 2008). Selection of market food which is predominantly foods that are low nutrient dense, high in saturated fat and sugar, highly refined and low in fibre will further deprive micronutrients in the diet of indigenous peoples. For the Orang Asli communities, the transition from traditional subsistence agriculture to cash crop farming such as palm oil and rubber and decreased forest reserve for hunting and gathering could significantly change their sources of food supply and diet composition. Consequently, the low nutritional quality of the diets could predispose the Orang Asli, particularly children, to poor growth and development.

This study assessed the nutritional status and dietary diversity of Orang Asli children (1-6 years) of the Jah Hut, Temuan

and Che Wong sub-tribes in Krau Wildlife Reserve. Specifically, this study examined the relationship between dietary diversity and nutritional status of these children.

## METHODOLOGY

### Study background and subjects

This cross-sectional descriptive study was conducted at Krau Wildlife Reserve (KWR), Pahang where the villages of three sub tribes of Orang Asli, namely Jah Hut, Che Wong, and Temuan, are located. A list of 26 villages was obtained from the Department of Wildlife and National Parks (Perhilitan), Kuala Gandah; however only 16 villages (8 Jah Hut, 5 Che Wong and 3 Temuan) were included in the study due to lack of accessibility to the villages or because the villages no longer existed. Data collection was carried out from August to November 2009. A total of 449 households within the 16 Orang Asli villages were visited. Households with children 1 to 6 years of age and mothers as the main caregivers (n=178) were identified and invited to participate in this study. However, only 162 households consented to participate in the study.

The study protocol was approved by the Medical Research Ethics Committee of Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. Permission was obtained from the Department of Orang Asli Affairs (JHEOA) and Department of Wildlife and National Parks (PERHILITAN). Initialised or verbal informed consent was sought from mothers of eligible children prior to the study.

### Measurements

Mothers were interviewed in the home setting using a pre-tested questionnaire for socio-demographic and dietary information. Both mothers and children were measured for weight and height.

*Dietary diversity assessment*

Dietary diversity was assessed using an adapted version of Food and Agriculture Organization Diet Diversity Questionnaire (FAO, 2008). The questionnaire has 18 food groups in which locally available foods consumed by the Orang Asli (Haemamalar, Zalilah & Neng, 2010) were incorporated into the respective food groups. Mothers were asked on the frequency of food groups consumed by children inside and outside the home over the last 7 days. Dietary diversity score (DDS) was calculated based on the first 15 food groups which emphasise micronutrient consumption. Each food group was given 1 score (food group score, FGS) if any food item within the food group was taken daily or at least 3 times in the last 7 days (Arimond & Ruel, 2004). The sum of FGS indicates DDS. A higher DDS reflects a more diverse diet with more food groups being consumed. The last three food groups (instant / processed food, sweets, and tea / coffee) were not counted in the dietary diversity score (DDS) as they contain negligible amounts of micronutrients. However, these food groups were included in the questionnaire for a better understanding of food group consumption pattern (FAO, 2008).

*Anthropometric measurements*

Height and weight of both children and mothers were measured using SECA body meter and TANITA digital weighing scale, to the nearest 0.1cm and 0.1kg respectively. Each measurement was taken twice and the average was determined. Weight-for-age and height-for-age of the children were computed and expressed as z-scores by using WHO Anthro and AnthroPlus software and classified according to the WHO Child Growth Standards (2006) (WHO Multicentre Growth Reference Study Group, 2006) and WHO Growth Reference (2007) (de Onis *et al.*, 2007) (for children $\leq 5$

years of age and > 5 years of age, respectively. Body Mass Index (BMI) (kg/m$^2$) of mother was calculated and categorised according to the WHO classification (WHO, 2000).

**Statistical analysis**

Data were analysed using Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to describe all study variables. Linear regression was used to determine the relationship between each independent variable and dependent variable. Multiple linear regression was then run to identify factors contributing to dietary diversity and nutritional status of children. A probability level (p) of <0.05 was set as statistically significant.

## RESULTS

A total of 216 children (53.2% boys and 46.8% girls) aged 1 to 6 years from 162 households participated in this study (Table 1). The majority (69.9%) of the children were of Jah Hut sub-tribe. The mean age of children was 41.44 [95% CI – 39.08, 43.81] months. About 46.0% of mothers had no formal education. More than half (53.7%) of mothers had normal body weight, while 11.1% were underweight, 27.8% overweight and 7.4% obese. The mean household income and income per capita were RM 310.43 [95% CI - 285.29, 335.58] and RM57.34 [95% CI - 52.16, 62.53] respectively. About 50.9% and 61.6% of children were underweight and stunted respectively (Table 2). Slightly more male children were underweight and stunted than female children.

Out of the possible 15, the mean DDS was 6.38 [95% CI - 6.10, 6.65] (Table 3). The DDS of most children were in the lower (56.0%) and middle (36.1%) tertiles. The cereal group had the highest score (FGS=1.00) followed by oils and fats (0.95 [95% CI - 0.92, 0.98]). The mean FGS of dark green leafy vegetables was 0.80 ([95% CI - 0.75, 0.85]) which was much higher than the mean FGS of other vegetables (0.44 [95% CI - 0.37, 0.50]) and vitamin A rich vegetables and tubers (0.21 [95% CI – 0.15, 0.26]). Meanwhile, the mean FGS of organ meat was the lowest (0.03 [95% CI - 0.01, 0.05]).

Table 4 indicates the relationship between socio-demographic characteristics and dietary diversity score (DDS). The linear regression shows that sub-tribal group (B=-1.004, $p<0.01$) and mother's BMI (B=0.070, $p<0.05$) were significantly related to DDS. Multiple regression indicates that children of Temuan and Che Wong sub-tribes [dummy Jah Hut (B=-1.022, $p<0.001$)], older children (B= 0.017, $p<0.05$) and children with mothers having more years of schooling (B=0.076, $p<0.05$) had better DDS

Table 5 shows the relationship between socio-demographic characteristics and dietary diversity score with children's weight-for-age (WAZ) and height-for-age (HAZ) z-scores, respectively. In the multiple regression models, DDS was consistently related to weight-for-age (B= 0.203, $p<0.001$) and height-for-age (B= 0.123, $p<0.05$) in that higher DDS was related to better child nutritional status. In addition, children of mothers with higher BMI had higher WAZ while older children and non Jah Hut children had higher HAZ.

## DISCUSSION

The prevalence of underweight and stunting in the present study is comparable to the findings of other studies (Zalilah & Tham, 2002; Wan Norlida *et al.*, 2007; Nurfaizah *et al.*, 2009) in which the prevalence of underweight and stunting among Orang Asli children were reported to be in the range of 40%-65%. Stunting (61.6%) remains the most prevalent under-nutrition problem among the Orang Asli children. The high prevalence of chronic undernutrition could reflect the slow nutrition progress and disease stress such as infections within the Orang Asli population due to an

**Table 1.** Sample characteristics

| | *n (%)* | *Mean [95% CI]* |
|---|---|---|
| **Households (N=162)** | | |
| Household size | | 5.96 [5.60, 6.31] |
| Number of children | | 3.88 [3.52, 4.23] |
| Household income (RM) | | 310.43 [285.29, 335.58] |
| Income per capita (RM / person) | | 57.34 [52.16, 62.53] |
| **Mothers (N=162)** | | |
| Age (years) | | 30.85 [29.62, 32.09] |
| Schooling (years) | | 3.67 [3.02, 4.32] |
| None | 75 (46.3) | |
| Preschool | 6 (3.7) | |
| Primary school | 56 (34.6) | |
| Lower secondary school | 16 (9.9) | |
| Upper secondary school | 9 (5.6) | |
| Weight (kg) | | 52.06 [50.28, 53.8] |
| Height (m) | | 1.48 [1.47, 1.49] |
| Body mass index (BMI) (kg / $m^2$) | | 23.60 [22.86, 24.35] |
| Underweight | 18 (11.1) | |
| Normal | 87 (53.7) | |
| Overweight | 45 (27.8) | |
| Obese class 1 | 5 (3.1) | |
| Obese class 2 | 6 (3.7) | |
| Obese class 3 | 1 (0.6) | |
| **Children (N=216)** | | |
| Sex | | |
| Boy | 115 (53.2) | |
| Girl | 101 (46.8) | |
| Sub-tribe | | |
| Jah Hut | 151 (69.9) | |
| Temuan | 34 (15.7) | |
| Che Wong | 31 (14.4) | |
| Age (months) | | 41.44 [39.08, 43.81] |
| 12.0 – 23.9 | 45 (20.8) | |
| 24.0 – 35.9 | 39 (18.1) | |
| 36.0 – 47.9 | 42 (19.4) | |
| 48.0 – 59.9 | 55 (25.5) | |
| 60.0 – 71.9 | 35 (16.2) | |
| Birth order | | 3.47 [3.17, 3.77] |
| 1-3 | 122 (56.5) | |
| 4-6 | 66 (30.6) | |
| 7-9 | 28 (13.0) | |

**Table 2.** Nutritional status of Orang Asli children

| | *Male* | | *Female* | | *Total* | |
|---|---|---|---|---|---|---|
| | *n (%)* | *Mean [95% CI]* | *n (%)* | *Mean[95% CI]* | *n (%)* | *Mean[95% CI]* |
| Weight (kg) | | 11.99 [11.39, 12.59] | | 11.83 (11.19, 12.46) | | 11.91 [11.48, 12.35] |
| Height (cm) | | 88.82 [86.43, 91.21] | | 89.77 [89.29, 92.24] | | 89.26 [87.56, 90.97] |
| Weight-for-age z score [a, b] | | -1.98 [-2.23, -1.74] | | -1.93 [-2.16, -1.71] | | -1.96 [-2.13, -1.80] |
| Severe underweight (<-3SD) | 23 (20.0) | | 20 (19.8) | | 43(19.9) | |
| Moderate underweight(<-2SD) | 36 (31.3) | | 31(30.7) | | 67(31.0) | |
| Normal (≥ -2SD to ≤ +2SD) | 54 (47.0) | | 50(49.5) | | 104(48.2) | |
| High (> +2SD) | 2 (1.7) | | 0 (0.0) | | 2(0.9) | |
| Height-for-age z score [a, b] | | -2.42 [-2.71, -2.12] | | -2.16 [-2.45, -1.88] | | -2.30 [-2.50, -2.09] |
| Severe stunting (<-3SD) | 40 (34.8) | | 33(32.7) | | 73(33.8) | |
| Moderate stunting(<-2SD) | 34 (29.6) | | 26(25.7) | | 60(27.8) | |
| Normal (≥ -2SD to ≤ +2SD) | 39 (33.9) | | 41(40.6) | | 80(37.0) | |
| High (> +2SD) | 2 (1.7) | | 1 (1.0) | | 3(1.4) | |

[a] WHO Child Growth Standards (2006) for children ≤ 5 years of age
[b] WHO Growth Reference (2007) for children > 5 years of age

**Table 3.** Dietary diversity score and food group score of Orang Asli children

| | *n (%)* | *Mean [95% CI]* |
|---|---|---|
| Dietary Diversity Score (DDS)† | | 6.38 [6.10, 6.65] |
| Upper tertile (10-12) | 17 (7.9) | |
| Middle tertile (7-9) | 78 (36.1) | |
| Lower tertile (2-6) | 121 (56.0) | |
| Food Group Score (FGS) | | |
| Cereals | | 1.00 |
| Oils and fats | | 0.95 [0.92, 0.98] |
| Sweets* | | 0.87 [0.82, 0.91] |
| Dark green leafy vegetables | | 0.80 [0.75, 0.85] |
| Fish | | 0.77 [0.72, 0.83] |
| Tea / coffee* | | 0.73 [0.67, 0.77] |
| Malted drinks | | 0.50 [0.43, 0.56] |
| Eggs | | 0.46 [0.40, 0.53] |
| Other vegetables | | 0.44 [0.37, 0.50] |
| Flesh meats | | 0.43 [0.36, 0.49] |
| White tubers and roots | | 0.22 [0.16, 0.27] |
| Vitamin A rich vegetables and tubers | | 0.21 [0.15, 0.26] |
| Milk and milk products | | 0.19 [0.14, 0.24] |
| Other fruits | | 0.16 [0.11, 0.21] |
| Vitamin A rich fruits | | 0.13 [0.08, 0.17] |
| Legumes, nuts, and seeds | | 0.10 [0.06, 0.14] |
| Instant / processed food* | | 0.09 [0.05, 0.13] |
| Organ meat | | 0.03 [0.01, 0.05] |

DDS: Sum of food group score; †possible DDS= 0-15
* Not included in DDS

impoverished environment (Khor & Zalilah, 2008). Stunted Orang Asli children could be at risk of overweight and obesity later in life. There is already evidence to show that overweight and obesity is a rising nutritional concern among the Orang Asli adults (Nurfaizah *et al.*, 2009; Haemamalar *et al.*, 2010)

More than half (56.0%) of young children in this study had a dietary diversity score below the mean score. The most commonly consumed food groups among the children are cereals, particularly rice which is a staple food; fats and oils where frying is a common food preparation method; green leafy vegetables, that is highly accessible from the forest or home gardens; and dried fish, mainly anchovy which is easily stored and prepared for the children. Other local studies (Zalilah & Tham, 2002; Wan Norlida *et al*., 2007) also reported that most Orang Asli children had low intakes of fruits, milk and milk products. Limited food group intake, or low dietary diversity, was also found among Orang Asli adults by Haemamalar *et al.* (2010), indicating an overall low variety of foods consumed by the Orang Asli population.

Our study showed that Orang Asli children consumed tea and coffee more frequently than malted drinks. About 69.0% of these children were reported to drink tea / coffee daily (data not shown). For growing children, tea and coffee are considered less nutritious beverages compared to malted drinks. Mothers also reported that either sugar or sweetened condensed milk was added into tea or coffee when the beverages

**Table 4.** Factors related to dietary diversity score (DDS) of Orang Asli children

| *Variables* | *Simple linear regression* | | | *Multiple linear regression* [a] | | |
|---|---|---|---|---|---|---|
| | *Unstandardised B Coefficients* | *SE* | *p* | *Unstandardised B Coefficients* | *SE* | *p* |
| Age of child (months) | 0.014 | 0.008 | 0.078 | 0.017 | 0.008 | 0.038* |
| Sex of child | 0.165 | 0.284 | 0.562 | 0.310 | 0.281 | 0.271 |
| Sub-tribe of child | -1.004 | 0.302 | 0.001** | -1.022 | 0.315 | 0.001** |
| Birth order of child | -0.003 | 0.063 | 0.967 | 0.135 | 0.169 | 0.426 |
| Mother's age (years) | -0.002 | 0.018 | 0.927 | -0.002 | 0.220 | 0.937 |
| Maternal years of schooling | 0.045 | 0.034 | 0.182 | 0.076 | 0.038 | 0.049* |
| Mother's BMI | 0.070 | 0.028 | 0.017* | 0.057 | 0.030 | 0.057 |
| Number of total children | -0.010 | 0.062 | 0.873 | -0.048 | 0.201 | 0.813 |
| Household size | -0.004 | 0.064 | 0.953 | 0.053 | 0.183 | 0.772 |
| Household income | 0.000 | 0.001 | 0.714 | -0.002 | 0.003 | 0.513 |
| Income per capita | 0.002 | 0.004 | 0.639 | 0.007 | 0.014 | 0.598 |

* $p< 0.05$; ** $p< 0.01$
Sex: Girl=0; Boy=1
Sub-tribe of child: 0= Non Jah Hut (Temuan and Che Wong); 1= Jah Hut
[a] $R^2 = 0.106$, $F=2.201$, $p<0.05$

**Table 5.** Factors related to weight-for-age z scores (WAZ) and height-for-age z scores (HAZ) of Orang Asli children

| | *Weight-for-age z scores (WAZ)* | | | | *Height-for-age z scores (HAZ)* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Simple linear regression* | | *Multiple linear regression* [a] | | *Simple linear regression* | | *Multiple linear regression* [b] | |
| *Variables* | *Unstandardised B Coefficients* | *SE* | *Unstandardised B Coefficients* | *SE* | *Unstandardised B Coefficients* | *SE* | *Unstandardised B Coefficients* | *SE* |
| Age of child (months) | 0.007 | 0.005 | 0.003 | 0.005 | 0.020*** | 0.006 | 0.018** | 0.006 |
| Sex of child | -0.052 | 0.166 | -0.051 | 0.153 | -0.255 | 0.209 | -0.206 | 0.199 |
| Sub-tribe of child | -0.538** | 0.177 | -0.278 | 0.176 | -0.832*** | 0.221 | -0.610** | 0.229 |
| Birth order of child | -0.012 | 0.037 | -0.037 | 0.092 | -0.039 | 0.046 | -0.041 | 0.120 |
| Mother's age (years) | 0.011 | 0.011 | 0.015 | 0.012 | 0.006 | 0.013 | 0.000 | 0.015 |
| Maternal years of schooling | 0.032 | 0.020 | 0.030 | 0.021 | 0.017 | 0.025 | 0.020 | 0.027 |
| Mother's BMI | 0.054** | 0.017 | 0.034* | 0.016 | 0.044* | 0.022 | 0.019 | 0.021 |
| Number of total children | -0.009 | 0.036 | 0.008 | 0.100 | -0.028 | 0.046 | -0.080 | 0.142 |
| Household size | 0.007 | 0.037 | 0.041 | 0.100 | 0.018 | 0.047 | 0.059 | 0.129 |
| Household income | 0.001 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 |
| Income per capita | 0.004 | 0.002 | 0.002 | 0.007 | 0.004 | 0.003 | -0.006 | 0.010 |
| Dietary diversity score | 0.238*** | 0.036 | 0.203*** | 0.038 | 0.181*** | 0.049 | 0.123* | 0.050 |

* $p < 0.05$; ** $p < 0.01$ , *** $p < 0.001$; Sex: Girl=0; Boy=1; Sub-tribe of child: 0= Non Jah Hut (Temuan and Che Wong); 1= Jah Hut

[a] $R^2 = 0.225$, F=4.908, $p<0.001$; [b] $R^2 = 0.178$, F=3.654, $p<0.001$

were given to the children. This could explain the daily consumption of sugar and sweetened condensed milk by 44.0% and 55.1% children, respectively. Further research is required to determine whether a high consumption of less nutritious beverages will replace the intake of nutritious foods and beverages and its impact on growth of Orang Asli children.

Our finding that Orang Asli children with higher DDS had better growth status is consistent with previous studies where dietary diversity score was positively related to weight-for-age (Zhang *et al.*, 2009) and height-for-age (Rah *et al.*, 2010). A diverse diet may increase the likelihood of young children meeting the nutritional requirements for better growth and development as nutrients are provided by a variety of plant and animal foods. Growth is positively associated with intakes of energy and nutrients from animal food sources such as meat and milk (Grillenberger *et al.*, 2006). Low intake of animal foods could put children at higher risk of micronutrient deficiency and stunting as these foods are good sources of protein and have higher bioavailability of minerals.

This study showed that Jah Hut children had lower DDS than Che Wong and Temuan children which could be due to differences in food sources and economic activities. While the Che Wong depends mainly on the forest resources and subsistence farming, the Temuan is highly dependent on market food. In the case of the Jah Hut, although they still practise subsistence farming (such as rice paddy and tapioca) and occasional hunting and gathering of forest resources, there is an increasing dependence on cash crops such as palm oil and rubber. Whether it is partial dependence on market foods or transition from traditional to modern diets that is contributing to poor dietary diversity of Jah Hut children needs to be further investigated.

Worldwide, indigenous peoples are experiencing nutrition transition where their diets are characterised by reduced intake of traditional foods and increased intake of market foods (Kuhnlein *et al.*, 2004). While consumption of predominantly processed market foods is related to higher risk of micronutrient deficiency and chronic diseases among indigenous peoples, dependence on traditionally animal food sources has been shown to improve diet quality of this population. Intake of locally cultivated plant foods by the indigenous children could increase their dietary diversity and enhance micronutrient intake (Cabalda *et al.*, 2011). Hence, the significance of market and traditional food consumption within the Orang Asli population and the impact on health and nutrition should be investigated. Different cultures of the sub-tribes could also explain the differences in DDS and nutritional status of the Orang Asli children. Culture may influence perceptions, beliefs and attitudes about foods and child feeding practices that could impact food intake of children. This study, however, did not examine these cultural aspects that may vary among the Orang Asli sub-tribes.

The finding that DDS was significantly higher among older Orang Asli children could be related to age-related increase in the number of foods consumed by children. The transition to table foods among older children enhances exposure towards a variety of food groups. Repeated opportunities of food tasting, together with reduced food neophobia, will improve children's acceptance of foods, particularly vegetables (Nicklaus *et al.*, 2005).

In the present study, maternal education and BMI showed positive relationship with DDS and WAZ of children, respectively. While children of mothers with lower education level were at higher risk of not meeting their nutritional requirements, mothers with higher years of schooling were more likely to provide healthier diets to their children (Hendricks *et al.*, 2006). Education may empower mothers to acquire nutrition knowledge that could shape healthier eating patterns of children. Maternal nutritional

status is a proximate determinant of children's nutritional status (Pramod Singh *et al*., 2009). There could be an inter-generational effect of better nutritional status of mothers on their children's well being in that children will have similar advantages as their mothers and grow to have better nutritional status.

The study has several limitations that need to be highlighted. As the data were cross-sectional, cause and effect relationship between independent factors with DDS and nutritional status could not be established. Nevertheless, the identification of these contributing factors is important for follow-up studies. The findings of this study could not be generalised to the Orang Asli population in Malaysia as the study sample was not representative of all Orang Asli sub-tribes. However, the information on nutritional status of Jah Hut and Che Wong children could add to the current literature on health and nutritional status of Orang Asli children as there is limited published information on these sub-tribes. As the study was conducted during the rainy season, there could be less dependence on forest food sources such as wild fruits and vegetables. In addition, the study period coincided with the end of the local fruit season (e.g. *durian*, *rambutan*, mangosteen, mangoes, *mata kucing*, *langsat*). These factors could reduce the fruit intake of children, especially if the Orang Asli depend on wild and cultivated fruits for consumption. Finally, only selected variables were investigated in relation to dietary diversity and nutritional status which may not give an overall picture of determinants of nutritional status of Orang Asli children. Despite these limitations, this study has provided important insights on the nutritional status of Orang Asli children in Krau Wildlife Reserve and its relationship to dietary diversity. This information can facilitate the development of culturally sensitive intervention strategies that could improve dietary intake and eventually the health and nutrition of the Orang Asli population in Malaysia.

## CONCLUSION

The results suggest that children with a diverse diet were more likely to have better nutritional status and that dietary diversity and nutritional status varied by age of children, sub-tribes, maternal education and nutritional status. Strategies to improve health and nutrition of young Orang Asli children should address dietary diversity, particularly the consumption of local or traditional foods that are accessible to the Orang Asli communities. Dissemination of knowledge and skills in relation to selection and preparation of foods to Orang Asli parents is essential in light of increasing dependence on market foods. The study also highlights the importance of maternal education as a strategy to improve health and nutrition of Orang Asli children. Education may empower women to acquire health and nutrition knowledge which can benefit women's health and consequently children's well-being.

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