Nutrition and Epidemiologic Transition on Body Composition and Dietary Pattern of Indigenous Children and Adolescents in Peninsular Malaysia

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Abstract

Malaysia has been undergoing rapid nutrition and drastic epidemiologic transition over the past two decades. This has resulted in the evolution of synergistic existence between undernutrition, overnutrition and hidden hunger. The indigenous population of Malaysia known as Orang Asli continues to experience hunger pandemic in spite of industrialisation and economic growth. The objecctive of this study was to appraise the impact of nutrition and epidemiologic transition among indigenous children and adolescents. A cross-sectional study was carried among Semai Orang Asli children and adolescents (6-18 years) in Perak. Population Proportion to Size (PPS) was adopted to the sample size samples (N=747) representative of all districts in Perak. Demographic and socio-economic profile was collected using a pre-tested questionnaire, anthropometric measurements were recorded using World Health Organization standard protocols and 24- hour recall method was used to appraise the dietary pattern. Physical signs and symptoms for nutritional deficiencies were done with the help of trained public health nurses. The results were analyzed using SPSS22.0 software to establish possible associations. The findings showed that the incidence of underweight (2%) and malnutrition has declined significantly, with the emerging trends of overweight (19%) and obesity (0.7%) among school children and adolescents. Protein and Energy Malnutrition, Vitamin A, iron and iodine deficiencies, and dental fluorosis were commonly present among the study population. Poor inclusion of fruits and vegetables, legumes, and dairy foods leads to poor dietary diversity among these children. Nutrition and the epidemiologic transition has had a profound impact even on the indigenous population which warrants immediate attention and intervention.

Keywords: Epidemiologic transition, Malaysia, Nutrition transition, Obesity, Orang Asli

Introduction

The emergence of Corona Virus Disease (COVID-19) since November 2019 has shattered the world immensely recording the highest number of deaths surpassing other diseases. The syndemic effect of the hunger pandemic and COVID-19 pandemic has exacerbated food and nutrition insecurity in developed and developing countries alike. The countries that are currently in the nutrition transition phase are pushed into a situation of malnutrition with the coexistence of under and overnutrition that accelerate the rate of non-communicable disease (NCD) risk. Malaysia being an upper-middle-income country with rapid industrialization and economic growth over the last two decades is also facing a dual burden of malnutrition where it failed to provide nutritious and right food to those who are in need and overabundance of food shifting the magnitude of nutrition towards obesity epidemic. Malaysian economic transformation at each phase from primary to secondary to tertiary has brought about tremendous change in the job patterns that followed rapid industrialisation. The changes in the existing structure caused by globalization have brought the domestic economy closer to the international economy with improvisation in the acquisition of labour, income and the overall prosperity of the nation (Anto Cordelia T.A.D et al., 2019). This transformation has brought inevitable changes in the lifestyle of Malaysians. The dietary changes from natural and original foods to processed and high calorie dense foods accompanied by a sedentary lifestyle have increased the incidence of NCDs in the Malaysian population. These concurrent shifts in food patterns, physical activity, and body compositions

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have made Malaysia the fattest nation in South East Asian Regions. This has sent alarm bells to control the obesity pandemic which incurs more health care costs and food insecurity of the nation (Man et al., 2020).

Globally, the aborigines or indigenous population often experience inferior health, endure disability, lead a reduced quality of life and eventually die at a very young age. They are disproportionately contrived by natural calamities, conflicts and wars, and mostly dissent from gaining quality education, land holdings, and equal job opportunities. These aborigines tend to live in precarious financial conditions ad are abandoned and sidelined by health sectors in most countries. The Orang Asli are the oldest inhabitants of Peninsular Malaysia who originated from China and Tibet through the mainland of South East Asia followed by eventual settlement in Peninsular Malaysia some 5000 years ago (Nicholas et al, 2006). Orang Asli is a native Malay term that denominates the 18 sub-ethnic groups segregated under Semang (Negrito), Senoi, and Aboriginal Malay (Proto Malay). Senoi, to date, remains the largest group of Orang Asli in Peninsular Malaysia spread widely from the middle to the northern part of Peninsular Malaysia. Furthermore, the Semai inhabit the vast geographic terrain of Perak stretching from the central parts of the state and extending its boundary with the state of Selangor in the south.

Hayati et al, (2007) highlighted that the indigenous community experience a state of nutrition transition between hunter-gathering practices, subsistence agriculture, and a wider food chain. The Orang Asli are currently going through this phase of transition which needs more insight and thorough documentation of their health, nutrition, physical activity, and dietary practices at regular intervals. In nations undergoing an epidemiological and socio-economic transition as in Malaysia, the indigenous populations are not spared from being inflicted with nutrition transition which is witnessed by the shift in nutrition paradigm from consumption of a variety of traditional foods to the more westernized pattern of consuming processed and foods high in saturated fat and sugar with less fiber (Kuhnlein & Receveur, 1996). This transition also has allowed the emergence of non-communicable diseases in addition to communicable diseases (Ring, 2003). Several countries have reported the dietary pattern of adolescents such as China (Zhen et al., 2018), Australia (McNaughton et al., 2008), Brazil (Borges et al., 2018), and Scotland (Craig et al., 2009). Calorie dense foods (high in saturated fat and sugar), less consumption of vegetables, indulging in snacks, and a shift from traditional foods have been identified in these nationwide studies. In general, unhealthy dietary patterns among adolescents were positively correlated with higher risks of developing metabolic syndrome, depression, and adulthood obesity (Zhen et al., 2018; Kelishadi et al., 2018; Oddy et al., 2018; Cunha et al., 2018).

There exist a paucity of data on population-based samples to provide a wider understanding of the association between nutrition transition on the dietary pattern and body composition in adolescents especially among the indigenous community. Therefore, this study aims to appraise the nutritional status and dietary patterns and their association to socio-demographic characteristics, education, eating habits, and body composition among children and adolescents in Malaysia. We sincerely hope that this study will help the policymakers and public health practitioners to integrate the key elements of public health strategies, for non-communicable disease prevention and empower the underprivileged youth to foster good health and well-being.

Materials and methods

Study design and sampling techniques

Perak is the second largest state in Peninsular Malaysia and ranked second in terms of Orang Asli population (32%) next only to Pahang (36%). The Orang Asli of Peninsular Malaysia is segregated into three groups namely the Senoi, the Negritos, and the Proto-Malay. These three groups are further classified into 19 sub-ethnic groups. The Senoi are the largest group of Orang Asli in Peninsular Malaysia and are mainly distributed from the middle to the northern part of Peninsular Malaysia. For administrative purposes, the Senoi is further divided into six sub-ethnic groups. where only Semai and Temiar traditionally inhabit settlements in Perak. The Semai occupy a wider range of geographic terrain ranging from the central parts of Perak and stretching further down south occupying areas along the boundary of Selangor. The Semai community being widespread and larger in Perak, would represent the Senoi group and overall the indigenous population of Peninsular Malaysia.

This is a cross-sectional population-based epidemiological study carried out in a tribal setting involving the Semai indigenous community dwelling in the geographic terrain nearly three months prior to the study and until the survey period. The sample size was calculated using

a formula proposed by Allan (1999) for the estimation of a population proportion with a specified relative precision (25) as follows:

$$n = \frac{Z^2 P[1-P]}{d^2}$$

Where n is the required sample size, Z is the statistic corresponding to the level of confidence, P is expected prevalence, and d is precision (corresponding to effect size).

Assuming the overall nutritional insufficiency to be 40 percent as reported by Yusuf *et al*. (2007) among the Orang Asli population and using a Confidence Interval (CI) of 95 percent, relative precision of 10 percent and design effect of 2, the estimated sample size was 383 households. The sampling for this study was done with assistance from the Department of Orang Asli Affairs JAKOA, Perak, Malaysia. In order to ensure representative samples, stratified sampling was adopted in the survey. The assessment was done on seven districts and each district is considered as a primary stratum, and the secondary stratum is formed by the villages or village zones (urban and interior) formed within the primary stratum. The standard stratified cluster sampling technique was used to select the 40 clusters (also referred to as primary sampling units - (PSUs) or village zones in each district. The secondary sampling unit (SSU) was the households (HHs) within each selected village zone. The sample size for each stratum was reviewed and the sample size in some strata at the district level had been inflated to ensure the number met the minimum requirement for the analysis. From the list of villages obtained from JAKOA, a total of 40 village zones were selected, with 30 and 10 village zones selected from the rural and interior areas, respectively. All children between 6 to 18 years within the selected households were included in the study. Hospitalized persons, persons suffering from illnesses like HIV, cancer, and chronic illnesses were excluded from the study.

Study tools and assessment methods

Demography and Socio-economic Background

The information pertaining to the socio-economic data and demographic details such as age, sex, education, annual income of the family, and dietary pattern of the selected children in the households were collected through a pre-tested and validated questionnaire. The questionnaire was adopted from the National Nutrition Monitoring Bureau (NNMB), India reported by Brahmam (2007) with modifications to fit the Malaysian indigenous community. The questionnaires were designed in English and translated into the Aslian language with the locals in the field set up.

Clinical Examination

A comprehensive information and evaluation sheet was prepared with clinical signs to identify the nutritional deficiencies was done with assistance from the public health nurses.

Diet Survey

A twenty-four-hour recall record used by NNMB (2012) and reproduced according to local Malaysian setup was used to evaluate the individual dietary intake per day. Information pertaining to the meal pattern, type of preparation, amount of raw food, cooked food, and leftover was recorded. Details regarding participation in supplementary food programs or food basket programs were also collected.

Nutritional anthropometry

Stature was measured as recumbent length or standing height, the former for infants and young children using a measuring mat (SECA 210, Germany) to measure the recumbent length to the nearest 0.1 cm, and standing height of young children and adults were measured using a portable stadiometer with a horizontal headboard attachment. The children removed their shoes and stood erect with their heads, shoulders, and upper arms relaxed. The length between the standing surface and the top of the head was measured at the maximum point of exhalation. The measurement was done in duplicate to a precision of and 0.1cm and the mean value was calculated (WHO,1995).

The body weights of children and adults were measured using OMRON digital weighing scale to the nearest 0.1kg. The subjects were measured with light clothes and shoes removed. The measurement was repeated twice and the average was used (WHO, 2005). They were categorized into various grades of nutritional status using BMI Z-scores following the WHO Reference standards (2007) (<Median -3SD - Severe Thinness;-3SD to -2SD Moderate Thinness; -2SD to + 1SD-Normal; +1SD to + 2SD-Overweight; ≥Median + 2SD -Obesity)

Ethics approval and informed consent

The research protocol and survey instruments were

approved by the Ethical Research Committee of University Tunku Abdul Rahman (U/SERC/23/2014) and Avinashilingam Institute for Home Science and Higher Education for Women (AUW/IHEC-14-15/XPD-03) following a review process. Permission was also granted from JAKOA (Department of Orang Asli Affairs), Perak, Malaysia (JHEOA.PP.30.052Jld.6 (26) prior to data collection. The study complied with the conditions as suggested by the Ethics Review Committee. No invasive techniques were used in data collection on the selected subjects.

An information sheet and a consent form were made available for every respondent. For minors or disabled, signed consent was taken from the head of the family or guardian with a witness. For an illiterate respondent, a thumbprint was also taken from the respondent with a literate person as a witness. The identity (names, IC. number, and addresses) was not recorded in the questionnaire or information form. Confidentiality of the data was assured to all participants.

Results and discussion

The sociodemographic profile projected in Table 1 shows that the school dropout rate was higher (45% boys and 40% girls respectively). The reason is the proximity of schools from the Orang Asli kampungs and no proper transportation are available at present, which makes for the children who hail from interior forest fringes difficult to attend. The Orang Asli children were less motivated to attend school. The parents were less concerned about their children attending schools and older adolescents tend to follow their parents to do odd jobs to increase their family income. The education department has to consider this as a serious issue and do necessary arrangements for these indigenous children to enjoy equal rights to education on par with their other counterparts. More than 70% of the children come from below poverty level income households. This condition could be exacerbated at present due to lockdown and closing of borders and factories. Orang Asli should be treated fairly in providing job opportunities and women in the household could be taught skills that can help to incur income and thereby empower them in terms of socio-economic status.

From Table 2 it is evident that 10% of them did not eat snacks as against 5% in their non-indigenous counterparts but nearly 83% of them ate snacks one to three times a week. On the other hand, 88% of them did not eat out as against 11.9% of non-indigenous adolescents. In general, only one-fourth of them ate breakfast daily and almost 96% of them ate lunch daily in a week. Children and adolescents who attend schools have their breakfast or lunch at school through the school meal programme. Lunch is one of the meals that every orang asli consumes in a day and hence the rate is high.

Table 1. Sociodemographic profile of semai Orang Asli children (6-18 years) (N=747)

Characteristics	*n*	**%**	**95% CI**
Gender			
Male	388	51.94	49.5-52.56
Female	359	48.06	49.3-51.6
Education (Male)			
Primary (*n*=166)	92	23.71	21.02 - 25.49
Secondary (*n*=222)	118	30.41	28.11 - 33.64
School Droupout	178	45.88	42.88 - 49.14
Education (Female)			
Primary(*n*=159)	96	26.74	23.88 - 29.10
Secondary (*n*=200)	118	32.87	29.95 - 35.46
School Droupout	145	40.39	36.81 -43.44
Household Income	(N=747)		
HH Income (RM)			646.15 ± 182.9

Table 1. (Continued)

Income per capita			137.6 ±69.05
Classification based on Poverty Level Income (ETP, 2012)*			
Poor	443	59.31	
Hard core poor	91	12.12	

Table 2. Dietary pattern of semai Orang Asli children (6-18 years) (N=747)

Characteristics	*n*	%	95% CI
Snack intakes per week			
≥ 4 times	46	6.16	5.11 – 7.34
1-3 times	623	83.40	80.44 -88.39
Never	78	10.44	8.13 – 12.41
Eating out per week			
≥ 4 times	5	0.67	0.33-0.79
1-3 times	85	11.38	9.12 – 14.02
Never	657	87.95	83.44 -89.18
Breakfast intake per week			
Everyday	172	23.03	20.78 -26.90
1-6 days	402	53.82	50.78 -56.81
Never	173	23.15	20.15 -26.33
Lunch intake per week			
Everyday	711	95.18	90.17 – 96.43
1-6 days	23	3.08	1.18 -4.97
Never	13	1.74	0.98 – 3.13
Partake in School Meals			
Yes	311	41.63	39.55 -44.08
No	436	58.37	55.36 – 60.62

The prevalence of moderate thinness, in general, is only 2% with 1.7% having severe thinness. A vast majority of the children fall under the normal category while a shift from underweight to overweight is also evident. In a country like Malaysia which is in nutrition transition, the trend of overnutrition among adolescents and adults and subsequent undernutrition in young children is characteristic of transition which is evident in many developing countries. The magnitude of malnutrition has declined from young children as they enter school and are in a transition period from childhood to adolescence. Though the incidence of underweight and malnutrition has declined significantly, the study also witnessed the emerging trends of overweight and obesity among school children and adolescents (Table 3). Several studies have published the co-existence of undernutrition among infants and young children and overnutrition among adolescents in Malaysia (Mohd Shukri and Abdul Basir (2016); Koo et al. (2014). The results of NHMS III and IV are quite contradictory with the current findings in which the prevalence of thinness was higher (12.2%) compared to obesity (6.6%). The difference could be due to the larger sample size in NHMS IV (Baharudin et al., 2019) and the study location.

Among the age groups, the prevalence of overweight and obesity was higher among children between 10-14 years old with 21.9% and 1% respectively. This is

closely followed by the older adolescents (15-18 years) with 17.3% and 0.4% respectively. The national data (NHMS, 2016) reported 9.6% of children between 15-17 years and 14.4% of 10-14 years old children to be obese. The whole nation is witnessing childhood obesity to be an emerging problem of public health issue.

Among the gender, female children between the age group of 6-9 years (7.5%) and older adolescents (1.5%) were found to have poor nutritional status and nearly 80% of the children studied were under the normal range. A similar pattern was also seen among the school-going boys where the prevalence was 6.8% and 7.5% for severely and moderately thin groups respectively. The prevalence of overweight and obesity is high among boys than those of girls in all age categories. The nutritional status of school children and especially adolescents are moving towards the right which is overweight and obesity. Nationwide large-scale studies also show the increase in overweight and obesity among adolescents (NHMS III, 2006 and NHMS IV, 2011) Results of data in 2006 projected the prevalence rate of overweight at 6.0% for boys and 4.7% for girls (MOH, 2006), while data 2011 showed a prevalence rate of obesity as 7.6% for boys and 4.6% for girls (Ahmad et al., 2015).

We noted that the number of students enrolled under the hostel facilities was higher among the females than in males. Thus for children over 12 years old, there was a fewer number of girls who were stunted compared to the boys. The current study also establishes the fact that female children have abated in the severity of malnutrition over the past decades.

Less than 20% of the school-going children and adolescents were devoid of any nutritional deficiencies and the remaining 80% or less were affected with any form of nutritional deficiencies.

Based on the signs of hair discoloration, (or hair alopecia) which is a common physical sign for children and adults suffering from protein and calorie malnutrition, is obviously seen in all groups in both genders (Table 4) More visibility was observed in children of 6-9 years and it decreases with age. The incidence is higher in females in all age groups except for 10-14 years where the symptom was more pronounced among the males. This could be due to less intake of protein of good quality and quantity. Their main source of protein is small fish and soy milk with less amount coming from other poultry and flesh food sources.

Table 3. Percent distribution of Child nutritional status aged 6-18 years

		BMI-for-age (%) Males				
Age groups	***n***	**% <-3SD Severe Thinness**	**% <-3SD to -2SD Moderate Thinness**	**% >-2SD to+1SD Normal**	**% >+1SD to +2SD overweight**	**% > +3SD Obese**
6-18 years	388	2.6	1.8	74.5	20.3	0.8
6-9 years	81	11.1	7.4	60.5	19.8	1.2
10-14 years	156	0	0.6	75	23.8	0.6
6-18 years	151	0.7	0	81.5	17.1	0.7
BMI-for-age (%) and Females						
6-18 years	359	0.8	2.3	79.6	16.7	0.6
6-9 years	80	2.5	7.5	78.7	11.3	0
10-14 years	145	0	0	79.3	19.3	1.4
15-18 years	134	0.7	1.5	80.6	17.2	0
BMI-for-age (%), Pooled						
6-18 years	747	1.7	2	76.6	19	0.7
6-9 years	161	6.8	7.5	69.1	16	0.6
10-14 years	301	0	0.3	76.8	21.9	1
15-18 years	285	0.7	0.7	80.9	17.3	0.4

Vitamin A deficiency is common among children and adolescents of Malaysia as reported in various studies (Koo et al., 2015); Khor G.L (2002). In the present study, the rates were lower than that reported by Koo et al. (2015) and it was much lower than a result published by Hesham Al-Mekhlafi et al. (2008) among orang asli children of 7-12 years which was 27.4%. The variation could be that the earlier studies were based on mean retinol concentration whereas the current study explains only on physical examination. According to WHO definition, Vitamin A deficiency in Malaysia is not a public health problem with only mild prevalence. The various symptoms of vitamin A deficiency considered in the present study were, phrynoderma, xerophthalmia, conjunctival xerosis, and bitot's spot. All four symptoms were prevalent in higher percentages in females compared to males. Less consumption of green leafy vegetables and yellow vegetables can be one of the reasons. The yellow vegetables rich in carotene like carrots are expensive for the orang asli and hence its inclusion in their meals is very rare.

Riboflavin deficiency was more pronounced among the orang asli children. The various symptoms observed were angular stomatitis, cheilosis, and glossitis. The prevalence was 8.22% in the present study with a higher prevalence among females (10%) as against 6% in males. The symptoms were more common among females in all age groups and young children and children between 10-14 years are more inflicted at 9% each. The symptoms of ariboflavinosis appear when the mean riboflavin intake is less than 0.5-0.6 mg/day. In the current study, the mean riboflavin intake was less than 0.5 among 7-9 years old children while it is between 0.5-0.6 among older children. All the age groups did not meet the recommended levels of RNI. This deficit could also be the reason for the appearance of symptoms.

The prevalence of knocked knees (bowed legs) which is a symptom of rickets, a vitamin D deficiency was seen in 2.56% of the children studied again girls showing higher prevalence compared to boys. A study by Nabilla Al-Sadat et al. (2016) where vitamin D status was very much higher with 78.9% of the children suffering from vitamin D deficiency. A study by Koo et al., (2015) also found vitamin D deficiency in about 47.5% of the studied population which used biochemical measurements. Malaysia being a tropical country and lying closely next to the equator, which is exposed to sunshine all through the year, large scale studies have reported a greater prevalence of vitamin d deficiency. Vitamin D deficiency is a common phenomenon even in countries with abundant sunshine and hence tropical countries are not spared from vitamin D deficiency. All studies in the literature are in line with the present study that female is more susceptible to vitamin D deficiency.

Dental fluorosis is due to the presence of excess fluoride in drinking water which forms yellow discoloration of teeth. Overall prevalence was at 15% while it was higher among primary school children (26%) and highest among girls of the same age category (31%) Dental caries is the breakdown of teeth that is caused by bacterial action (Haque, 2014). Dental caries is very common among the orang asli young children, adolescents, and adults alike. Though the degrees of cavity and causes are different, the main cause found in this study was due to unhygienic practices followed by the orang asli. In general, around 9% of children examined showed signs of cavities which is more commonly present among the young children of this group. Most of the children agreed that they do not use a toothbrush and smaller children go without brushing teeth even for days together. According to Marsh (2015), low socio-economic status is also found to have an association with dental caries. This is true in the case of the study population as most of them belong to poor and hard core poor. Awareness has to be given to oral health care to combat or reduce the incidence of cavities among children and adolescents.

The overall prevalence rate observed was 3.27% and the highest recorded for adolescents of reproductive age followed by children of 10-14 years. Iron deficiency anemia symptom was not found in primary school children. This haunts the females as they start menarche and also those of childbearing age. The presence of koilonychia was the major determinant in examining iron status. Iron deficiency anemia is the common micronutrient malnutrition in Malaysia (Khor G.L, 2002). A decrease in the intake of iron-rich foods, especially dark green leafy vegetables, can propagate the symptom. The low prevalence can be accredited to the efforts by Family Health Clinics in disseminating nutrition knowledge for preparing a balanced diet, proper cooking methods to retain most nutrients, and also on propagating the importance of iron-rich foods to the impoverished community.

The present study revealed that only 2% of the children who participated in the study were presented with palpable and visible thyroid and that it affects the female children especially those of younger age. Around 2.2 billion people are concentrated in iodine

Table 4. Prevalence of nutritional deficiency signs

Age groups	Sex	N	NAD- (No abnormality detected)	Hair dis- coloured	Night blindness	Conjuntival Xerosis	Bitot's spot	Angular stomatitis	Cheilosis	Glossitis	Phrynoderma	Knock-knees	Dental caries	Dental fluorosis	koilonychia	Palapable thyroid	Visible thyroid
6-9 years	Male	81	20.99	20.99	0	3.7	4.94	14.81	8.64	3.7	4.94	3.7	16.05	21	0	0	2.47
	Female	81	14.81	28.4	1.23	6.17	9.88	9.88	8.64	12.4	1.23	1.23	9.88	30.9	0	1.23	3.7
	Total	162	17.9	24.69	0.62	4.94	7.41	12.35	8.64	8.02	3.09	2.47	12.96	25.9	0	0.62	3.09
10-14 years	Male	156	49.36	8.97	1.28	1.92	0.64	3.21	5.13	8.97	1.92	0.64	8.33	12.2	3.21	0.64	1.28
	Female	145	28.97	6.9	3.45	2.76	3.45	13.1	5.52	18.6	6.21	4.14	8.28	14.5	4.14	2.76	2.76
	Total	301	39.16	7.94	2.37	2.34	2.04	8.15	5.32	13.8	4.06	2.39	8.3	13.3	3.67	1.7	2.02
15-18 years	Male	151	35.09	1.4	1.75	0.7	0.7	1.75	3.86	5.61	2.46	2.11	4.56	4.56	3.51	0.35	1.4
	Female	134	16.49	3.86	3.86	2.81	0.7	3.16	6.67	14.4	3.51	3.51	5.96	7.37	8.77	0.35	1.75
	Total	285	25.79	2.63	2.81	1.75	0.7	2.46	5.26	10	2.98	2.81	5.26	5.96	6.14	0.35	1.58
Pooled	Male	388	35.14	10.46	1.01	2.11	2.09	6.59	5.88	6.1	3.11	2.15	9.65	12.6	2.24	0.33	1.72
	Female	360	20.09	13.05	2.85	3.91	4.68	8.71	6.94	15.1	3.65	2.96	8.04	17.6	4.3	1.45	2.74
	Total	748	27.62	11.75	1.93	3.01	3.38	7.65	6.41	10.6	3.38	2.56	8.84	15.1	3.27	0.89	2.23

deficiency endemic areas worldwide (Mohammadzadeh et al., 2011). In a large scale study reported by Law et al. (2018) conducted among school children of 8-10 years, it was found that 7.9% of the orang asli showed symptoms of visible and palpable goiter which is the highest among the study population. The mean intake of iron was almost the same among school-going children whereas the intake of iron-rich food was less than half the amount consumed by males in the case of female children of pubertal age. The mean consumption of folate was more in the case of boys except for 10-12 years old children where girls consume more folates than boys.

All children were able to meet only 60-70% of calcium recommendation and primary school children receive only 50-55% of calcium required for their age. The average consumption of vitamin A and thiamin ranged between 55-65% of RNI while the intake of riboflavin was less than 50% in boys of 10-12 years and 16-18 years. The orang asli met 60-70% of their daily requirements for niacin and vitamin C. The reasons for not achieving the recommended levels were lack of dietary diversity, consuming food in abundance when available and starving when it was not available. When we studied the inclusion of food groups in everyday meals, the distribution of food groups was insufficient and certain food groups like milk and milk products, legumes, green leafy vegetables, and fruits were missing in most of the households.

The reason for better intake in terms of nutrients especially among secondary school students corresponds to their enrollment in hostels set up by the government

to improve the educational status of these marginalized communities. The secondary school children who benefit from these hostels had a better nutritional profile compared to those who did not go to school or dropped from school. The food is served at five frequencies including energy-dense food and protein source. There are separate hostels for boys and girls and the majority of the boys did not avail of this opportunity. There are more dropouts among the boys as they tend to follow their parents to odd jobs or simply do not attend school. The diet of most orang asli is monotonous and they tend to use soy sauce for most food preparation which tends to increase their sodium intake. Rice, especially hill rice, is the staple food of the semai, which is replaced with tapioca during deprivation of the former. Small fishes and sweetened, condensed milk are the major protein sources, and tapioca and petai leaves are the predominant vitamin C source. The use of lentils and food of animal origin are lacking in their diets. The proximity to nearby towns to procure food and types of food procured also influences their nutrient intakes and nutritional status in general.

Table 5. Mean nutrient intake of Semai Orang Asli children (6-18 years)

Age group		7-9 years			10-12 years			13-14 years			15 years			16-18 years		
Nutrients	**Gender**	**Mean**	**±STD**	**% Intake**	**Mean**	**±STD**	**% Intake**	**Mean**	**±STD**	**% Intake**	**Mean**	**±STD**	**% Intakw**	**Mean**	**±STD**	**% Intake**
Energy (Kcal)	Male	1240.02	332.38	**69.66**	1730.91	437.85	**79.40**	2058.29	339.71	**76.52**	1925.01	415.99	**71.56**	2231.9	427.39	**78.59**
	Female	1068.41	251.49	**67.20**	1666.31	379.53	**83.73**	1841.38	320.54	**84.47**	1855.22	338.25	**85.10**	1830.1	344.57	**89.27**
Protein (g)	Male	16.79	3.86	**53.47**	38.20	12.82	**84.89**	39.01	11.58	**61.92**	36.26	8.96	**57.55**	43.71	10.14	**67.25**
	Female	16.49	3.76	**51.53**	35.90	11.62	**78.04**	31.01	8.58	**56.38**	32.25	9.02	**58.64**	32.10	8.73	**59.45**
Calcium (mg)	Male	391.14	66.08	**55/88**	680.27	113.51	**68.03**	665.79	126.25	**66.58**	714.26	155.62	**71.43**	698.41	150.58	**69.84**
	Female	389.09	67.47	**55.58**	693.07	129.07	**69.31**	680.16	147.69	**68.02**	684.78	148.52	**68.48**	674.59	149.24	**67.46**
Iron (mg)	Male	5.10	1.18	**56.66**	10.00	2.73	**66.67**	17.49	2.58	**116.62**	18.36	3.87	**96.65**	17.20	2.18	**90.52**
	Female	5.06	1.21	**56.27**	9.33	2.35	**66.63**	18.89	3/99	**57.24**	19.09	4.06	**61.58**	18.75	3.48	**60.49**
Vitamin A (µg)	Male	309.89	78.95	**61.98**	369.44	80.04	**61.57**	349.66	61.66	**58.28**	377.67	88.41	**62.94**	360.57	77.57	**60.10**
	Female	301.38	72.57	**60.28**	359.24	74.61	**59.87**	348.09	62.39	**58.02**	355.90	69.87	**59.32**	350.23	71.41	**58.37**
Thiamin (mg)	Male	0.71	0.12	**78.64**	0.72	0.18	**60.00**	0.74	0.15	**61.62**	0.72	0.16	**59.73**	0.67	0;14	**55.52**
	Female	0.67	0.09	**74.28**	0.70	0.18	**63.31**	0.65	0.15	**59.12**	0.68	0.14	**61.88**	0;67	0.14	**60.57**
Ribofavin (mg)	Male	0.46	0.08	**50.96**	0.59	0.12	**45.38**	0.69	0.14	**53.05**	0.72	0.15	**55.38**	0.63	0.15	**48.56**
	Female	0.46	0.08	**50.66**	0.56	0.09	**55.95**	0.58	0.14	**58.13**	0.64	0.15	**64.25**	0.63	0.15	**63.13**
Niacin (mg)	Male	7.57	1.54	**63.05**	11.69	2.89	**73.06**	10.85	2.64	**67,84**	11.32	2.73	**70.72**	10.36	2.53	**64.77**
	Female	7,40	1.41	**61.67**	11.27	2.79	**70.42**	10.26	2.29	**64.15**	10.59	2.30	**66.16**	9.32	2.77	**58.25**
Vitamin C (mg)	Male	19.32	3.75	**55.20**	44.65	10.71	**68.69**	43.65	10.33	**67.16**	49.19	10.60	**75.68**	42.78	8.77	**65.81**
	Female	19.10	3.74	**54.57**	42.22	9.40	**64.95**	40.83	8.30	**62.83**	42.33	8.27	**65.12**	41.00	4.55	**63.08**
Folate (µg)	Male	178.26	52.56	**59.42**	239.72	65.41	**59.93**	273.62	65.64	**68.40**	287.81	65.50	**74.45**	268.07	61.20	**67.02**
	Female	174.02	50.96	**58.01**	253.12	90.77	**63.28**	258.08	68.87	**64.52**	271.35	59.74	**67.84**	260.11	55.15	**65.02**
Ildine (µg)	Male	78.22	14/65	**75.21**	75.34	10.45	**76.11**	60.68	4.66	**57.24**	67.03	12.81	**63.24**	65.07	5.09	**55.14**
	Female	73.18	13.39	**70.37**	71.26	10.12	**72.55**	59.90	6.06	**61.12**	64.41	9.09	**65.72**	61.80	7.19	**59.42**
Sodium (mg)	Male	1988.00	212.04	**132.53**	2298.00	152.20	**153.20**	2389.47	399.37	**159.30**	2388.51	486.31	**159.23**	2298.8	312.86	**153.32**
	Female	1895.33	204.60	**126.36**	1998.00	164.60	**133.20**	2378.56	431.98	**158.57**	2375.38	415.22	**158.36**	2089.5	303.15	**139.27**

Table 6. Protein and calorie adequacy status of children 6-18 Years

Age Group	Gender	P+C+	P+C-	P-C+	P-C-
6 - 9 years	Male	12 (35.29%)	1 (2.94%)	6 (17.65%)	17(50%)
	Female	7 (20.59%)	0	5 (14.71%)	22 (64.71%)
10-12 years	Male	25 (55.56%)	2 (4.44%)	6 (13.33%)	12 (26.67%)
	Female	23 (54.76%)	1 (2.38%)	9 (21.43%)	9 (21.43%)
13-14 years	Male	8 (23.53%)	1 (2.94%)	12 (35.29%)	13 (38.24%)
	Female	4 (12.5%)	0	19 (59.38%)	9 (28.13%)
15 years	Male	5 (14.29%)	0	7 (20%)	23 (65.71%)
	Female	6 (18.75%)	0	17 (53.13%)	9 (28.13%)
16-18 years	Male	8 (22.86%)	2 (5.71%)	9 (25.71%)	13 (37.14%)
	Female	9 (28.13%)	0	15 (46.88%)	8 (25%)

P+C+ Protein Adequate; Calorie Adequate; P+C- Protein Adequate; Calorie Inadequate
P-C+ Protein Inadequate; Calorie Adequate; P-C- Protein Inadequate; Calorie Inadequate

From Table 6, it is clear that 28% and 22% of the female and male children, in general, met the requirements for protein and calcium while a vast majority of them showed insufficiency in either calorie or protein or both. The worst affected is 15 year old boys (65.71%) and girls of primary school children (64.71%). Children of 10-12 years had better protein and calorie status with more than 50% meeting the requirement. In general, protein needs are not met by the orang asli school children and adolescents while they were better off in their calorie status. The study involves non-invasive methods whereby conclusions cannot be drawn and only predictions can be made. Hence methods involving biochemical and other methods can address this issue more intensively. This is only a one-time assessment and needs longitudinal studies to follow up and draw conclusions.

Conclusion

The rate of thinness has been reduced with a shift in nutritional status from underweight to overweight and obesity. Inappropriate dietary intake with overconsumption while food is available and fasting when unavailable could also contribute to this shift. Female children of pubertal and reproducing age suffer from iron deficiency anaemia while iodination of salt and fluoridation of water can curb iodine deficiency disorder and dental fluorosis. Poor inclusion of fruits and vegetables, legumes, and milk groups leads to poor dietary diversity among these children. Proper education and personal hygiene can offer little help in improving their nutritional status. The nutrition and epidemiologic transition have penetrated the indigenous population as well which is evident from the surge in overweight and obesity and subsequent micronutrient deficiencies. Under the current COVID-19 pandemic situation, this scenario can be exacerbated as schools are closed and children are deprived of school meals or supplementary meal programs. Job cuts and payroll cuts also would have pushed more families into the hunger pandemic. More in-depth studies are needed to assess the current situation of this marginalized community and introduce more intervention programs to curtail this hunger pandemic.

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Conflict of interest

No conflict of interest was reported by the authors.

Authorship

The corresponding author was responsible for data collection, field investigation, and preparation of the manuscript. Dr. Sylvia Subapriya was responsible for study design and overall project head. Prof. Khaled Islam helped with manuscript preparation and proofreading. Rv=V Lakshmi alias Anusha helped with statistical design and analysis.

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