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High prevalence of malnutrition and vitamin A deficiency among schoolchildren of rural areas in Malaysia using a multi-school assessment approach

Pei Yee Tan[1,2], Syahirah Nadiah Mohd Johari[2], Kim-Tiu Teng[1]*, Radhika Loganathan[1], Soo Ching Lee[3], Romano Ngui[2], Kanga Rani Selvaduray[1] and Yvonne Ai Lian Lim[2]*

[1]*Nutrition Unit, Division of Product Development and Advisory Services, Malaysian Palm Oil Board, No. 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang, Selangor, Malaysia*
[2]*Department of Parasitology, Faculty of Medicine, Universiti Malaya, Kuala Lumpur 50603, Malaysia*
[3]*Type 2 Immunity Section, Laboratory of Parasitic Diseases, National Institute of Allergy and Infectious Diseases, National Institute of Health, Bethesda, MD, USA*

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Abstract

Childhood malnutrition is known as a public health concern globally. The present study aims to assess the anthropometry and blood biochemical status of rural primary schoolchildren in Malaysia. A total of 776 children (7–11 years old) from ten rural primary schools from five states were included in this study. Nutritional outcomes were assessed based on sex, age group and school categories among the children (median age: 9 years (P25:8, P75:10)). The overall prevalence of malnutrition was 53·4 %. Vitamin A deficiency (VAD) was recorded at 20·6 and 39·8 % based on retinol and retinol-binding protein (RBP) levels, respectively. Anaemia, iron deficiency (ID), iron-deficiency anaemia (IDA) and elevated inflammation were found at 14·9, 17·9, 9·1 and 11·5 %, respectively. Malnutrition, VAD, anaemia, ID, IDA and elevated inflammation were more prevalent among Orang Asli (OA) schoolchildren compared with Non-Orang Asli schoolchildren. Higher occurrences of VAD and anaemia were also found among children aged <10 years. Retinol, RBP, α-carotene, ferritin and haemoglobin levels were lower among undernourished children. Besides, overweight/obese children exhibited a higher level of high-sensitivity C-reactive protein. Multivariate analysis demonstrated that OA school children (adjusted OR (AOR): 6·1; 95 % CI 4·1, 9·0) and IDA (AOR: 3·6; 95 % CI 1·9, 6·6) were associated with stunting among this population. The present study revealed that malnutrition, micronutrient deficiencies and anaemia are prevalent among rural primary schoolchildren in Malaysia, especially those from OA schools and younger age children (<10 years). Hence, more appropriate and targeted measures are needed to improve the nutritional status of these children.

Keywords: **Malnutrition: Vitamin A deficiency: Anaemia: Iron Deficiency: Inflammation**

Global malnutrition among children is primarily targeted at children aged less than five. WHO reported that an estimated 149 million and 45 million children aged under 5 years were stunted and wasted, respectively, whereas 38 million were overweight or obese globally[1]. In contrast, school-age children are scarcely monitored globally despite the significant impact of malnutrition on their health, cognitive function, academic performance and future economic productivity[2,3].

In Malaysia, it is known that malnutrition among children remains a health concern despite steady economic growth in the past decades. The Malaysian National Health and Morbidity Survey (NHMS) 2019 reported that the prevalences of stunting (height-for-age z-score (HAZ) < −2 SD), thinness (BMI-for-age z-score (BAZ) < −2 SD) and underweight (weight-for-age z-score (WAZ) < −2 SD), among children aged 5–17 years, were 12·7, 10·0 and 15·4 %, respectively[4]. Besides, 15·0 and 14·8 % of the same group of children were found to be overweight (2 SD < BAZ ≤ 3 SD) and obese (BAZ > 3 SD), respectively[4], thus highlighting the phenomenon of double burden.

Throughout childhood, micronutrients play significant roles in immune function, energy production, learning and cognitive functions[5]. It is estimated that micronutrient deficiencies affect at least 340 million children aged under five globally[6]. Vitamin A deficiency (VAD) is a significant public health problem affecting about one-third of children aged less than five in 1995–2015, with Southeast Asia recording the highest prevalence at

Abbreviations: HAZ, Height-for-age z-score; BAZ, BMI-for-age z-score; WAZ, weight-for-age z-score; COR, crude OR; hs-CRP, high-sensitivity C-reactive protein; ID, iron deficiency; IDA, iron-deficiency anaemia; NOA, Non-Orang Asli; OA, Orang Asli; RBP, retinol-binding protein; SES, socio-economic status; VAD, vitamin A deficiency.

* **Corresponding authors:** Yvonne Ai Lian Lim, email limailian@um.edu.my; Kim-Tiu Teng, email kimtiu@mpob.gov.my

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49·9 %[7]. VAD affects normal haematopoiesis, Fe metabolism and immune function[8] due to inadequate vitamin A intake or reduced availability of pro-vitamin A, namely carotenoids[9].

South-East Asian Nutrition Survey (SEANUTS) Malaysia reported a prevalence of 4·4 % VAD among children aged 6 months to 12 years old, with higher prevalence recorded in rural areas (6·4 %) compared with urban areas (3·8 %)[10]. In the same survey, it was found that the overall prevalences of iron deficiency (ID) and anaemia were 4·4 and 6·6 %, respectively. In addition, based on several studies conducted among Orang Asli (OA) (indigenous) schoolchildren, the prevalence of anaemia ranged from 26·2 % to 68·4 %, while VAD prevalence was at 27·4 %, and 36·7–54·9 % of them were found to be Fe deficient[11–14]. OA, which transliterates as original people in the Malay language, is the indigenous minority peoples of Peninsular Malaysia, which account for 0·7 % of the population of Peninsular Malaysia[15].

Despite nationwide anthropometric data being highly accessible as indicators of nutritional status in Malaysia, there are limited coherent and updated data on other nutrition and health indicators among children, mainly primary school-age children from rural areas. Thus, this study aims to collate data on the anthropometry and blood biochemical status of primary schoolchildren aged between 7 and 11 years old in the rural areas of Malaysia. The selected micronutrients (vitamin A, α-carotene, β-carotene and vitamin E), haemoglobin (Hb) status, ferritin status (indicator for ID), inflammation status and their associations with the nutritional status of the children were discussed in the present study. Potential socio-economics- and blood biochemical-related factors associated with stunting, the most prevalent malnutrition problem among this population, were examined.

Method

Study areas and subjects

This cross-sectional study was carried out between April 2017 and October 2017. Ten national primary schools from five different states located in rural areas of Malaysia were randomly selected based on suggestions and lists from the Ministry of Education (MOE) and Department of Orang Asli Development (JAKOA), taking into consideration the following criteria: (i) approval by the Ministry of Health (MOH) and MOE; (ii) schools with a population of at least fifty children; (iii) socio-economic status (SES) is generally poor; (iv) accessible by road transportation (for rapid transportation of samples to the laboratory for preservation and storage); (v) Malaysian children aged 7–11 years old and (vi) healthy at the point of the study period.

Among the selected schools, five schools are OA schools consisting of OA majority students (mainly of Semai and Temiar subgroups) and located in the vicinity of indigenous villages. At the same time, another five are Non-Orang Asli (NOA) schools consisting of NOA students (mainly of Malay, Kadazandusun and Iban ethnicities). The locations of the selected schools are shown in Fig. 1. Absent or ill children during the period of study were excluded.

The sample size was calculated based on the prevalence of stunting in rural areas at 12·7 %, as reported by NHMS 2019[4] according to the following formula[16]:

$$n \geq (z/m)^2 \times p(1-p) \quad (3)$$

where n is the minimum sample size, z is the standard score (1·96), m is the rate of sampling error (5 %) and p is the estimated prevalence of the variable in the population. At a significance level of 5 % and a confidence level of 95 %, a minimum sample size of 218 participants was required for this study.

Ethical approval, consent and socio-demographic data collection

The study was conducted according to the guidelines laid down in the Declaration of Helsinki. All procedures involving human subjects were approved by the Medical Research and Ethics Committee, MOH, Malaysia (NMRR-16–1905–32 547). Before the commencement of the study, the participants and parents/guardians were given an oral briefing on the objectives and methodology of the study. They were also informed that their child's participation was voluntary, and therefore they could withdraw from the study at any time. For all the literate guardians, written informed consents were obtained before the study commenced. As for illiterate guardians, verbal consents were obtained, followed by their thumbprint on the informed consent form. All the verbal consents were witnessed and formally recorded. Besides, an assent form was signed by the children themselves. Socio-demographic data, including age, sex and monthly household income of the children, were collected from student database obtained from the respective school's administration and parents. Monthly household income was categorised into two groups (<RM500 and ≥ RM500). A monthly household income of <RM500 was regarded as being below the Malaysia poverty income threshold[17]. The trial was registered on ClinicalTrials.gov with identification number NCT03256123 and can be accessed at https://clinicaltrials.gov/.

Anthropometric assessment

Height and weight measurements were performed using SECA Clara 803 and SECA 213 mobile stadiometer. The height measuring device was placed near the wall according to the device manual. During height measurement, students were requested to remove any footwear or hair accessories that may obstruct measurements. Height was recorded to the nearest 0·1cm. Before weight measurement was conducted, students were asked to empty their pockets. Calibrated SECA weighing scale was placed on a level surface. Each student was instructed to stand barefoot with minimal clothing and empty pockets at the centre of the scale. The weight was recorded to the nearest 0·1 kg. To reduce intra-observer error, height and weight were measured twice and the mean value was used for analysis. BMI was computed by dividing the measured weight (kg) by the square of height (m).

Anthropometric indices were computed using *anthro* R-package provided by WHO[18]. There were three anthropometric indices: (a) HAZ to assess stunting and (b) BAZ to assess thinness, overweight and obesity and (c) WAZ to assess underweight. All three anthropometric indices were expressed as differences from the median in standard deviation units or z-scores. Students were classified as stunted, thin and underweight if HAZ, BAZ and WAZ were less than 2 SD below the