ORIGINAL ARTICLE

Coexistence of Under- and Overnutrition among Under Five Indigenous (*Orang Asli*) Children in Terengganu, Malaysia

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ABSTRACT

Introduction: The coexistence of undernutrition and overnutrition—known as the double burden of malnutrition (DBM)—poses a growing public health concern, particularly among children in socioeconomically disadvantaged populations. In Malaysia, indigenous (Orang Asli, OA) children are especially vulnerable due to persistent socio-economic and environmental disadvantages. This study aimed to assess the prevalence of undernutrition, overnutrition, and their coexistence among under-five OA children in Terengganu, and to identify associated biological and socio-demographic factors. **Methods:** A total of 94 eligible OA children aged 6 to 59.9 months were purposively recruited from two settlements in Terengganu. Data were collected through anthropometric measurements and structured caregiver interviews. Nutritional status was assessed using the WHO Child Growth Standards and classified into undernutrition (stunting, underweight, wasting) and overnutrition (overweight/obesity). Binary logistic regression was used to identify factors associated with nutritional outcomes. **Results:** Undernutrition was highly prevalent, with 42.6% of children stunted, 30.8% underweight, and 7.4% wasted. Overnutrition, indicated by overweight or obesity, affected 10.7% of children, while 2.1% experienced DBM, characterised by concurrent stunting and overweight in the same individual. Higher birth weight was significantly associated with lower odds of undernutrition (AOR: 0.30, 95% CI: 0.10, 0.87) but higher odds of overnutrition (AOR: 14.98, 95% CI: 1.88, 119.35). **Conclusion:** Findings reveal a complex nutritional landscape among OA children in Terengganu, underscoring the dual challenge of under- and overnutrition. These results highlight the urgent need for culturally responsive, multisectoral interventions (i.e., maternal and antenatal care) addressing both forms of malnutrition and the broader structural determinants influencing OA child health.
Malaysian Journal of Medicine and Health Sciences (2026) 22(SUPP2):62-69. doi:10.47836/mjmhs.22.s2.9

Keywords: Undernutrition, Overnutrition, Double burden of malnutrition, Low birth weight, Orang Asli children

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INTRODUCTION

The global nutrition landscape is undergoing a profound transformation marked by the double burden of malnutrition (DBM) – the coexistence of undernutrition and overnutrition within populations, households, and even individuals. While undernutrition, characterised by stunting, wasting, and underweight, continues to affect millions of children worldwide, a parallel surge in overweight and obesity—particularly among children under five—has emerged as a pressing public health concern. According to the 2023 Joint Malnutrition Estimates by UNICEF, WHO, and the World Bank, approximately 148.1 million (22.3%) children under five were stunted, 45 million (6.8%) were wasted, and 37 million (5.6%) were overweight globally in 2022 (1). Similarly, Malaysia mirrors this global trend, struggling with both persistent and emerging forms of childhood malnutrition. As of 2022, 21.2% of children under five were stunted, 15.3% underweight, and wasted (11.0%), with an upward trajectory compared to 2015. Concurrently, overweight among children under five remains a significant concern, affecting approximately 6% of this age group (2). These patterns reflect a complex nutritional landscape influenced by dietary transitions, socioeconomic inequalities, and evolving lifestyles.

The Orang Asli (OA), the indigenous peoples of Peninsular Malaysia are also face a disproportionate burden of both under- and overnutrition. Despite their distinct socio-cultural identities and subsistence-based living, OA communities are not insulated from the structural forces driving the country's nutrition transition.

National surveillance data reveal a stunting prevalence of 43.8% and an underweight prevalence of 32.9% among OA children under five, more than double the national averages (3). These disparities reflect deep-rooted structural inequities, including limited access to healthcare, chronic food insecurity, poor sanitation conditions, and socio-economic marginalisation (4-8).

Over the past 15 years, numerous local studies have reported a substantial burden of undernutrition among OA children in Peninsular Malaysia, with prevalence ranging from 22.8% to 50.9% for underweight, 28.2% to 76.2% for stunting, and 7.9% to 52.0% for wasting (7-14). The differences in nutritional vulnerability across OA subgroups likely reflects differences in remoteness, market access, food systems, and exposure to modernization, compounded by socioeconomic disparities in income, education, and livelihoods, as well as cultural diversity in dietary practices and child-feeding norms (6). In some OA communities, increasing reliance on processed foods further contribute to the coexistence of undernutrition and overweight (9, 14). Previous studies have reported overweight among children even in deprived communities, with prevalence ranging from 0.9% to 7.7% (9, 12-14). Consistent with the national prevalence of 7.4%. Such patterns highlights double burden of malnutrition within OA children, which further complicates the public health landscape.

The early years of life, especially the first 1,000 days, represent a critical window for physical and cognitive development. Nutritional deficiencies during this period, coupled with repeated infections and poor living environments, can lead to irreversible growth faltering, impaired immune function, and heightened risk for metabolic disorders in later life (15-17). The coexistence of under- and overnutrition exacerbates this vulnerability, as excess weight in early life is now known to contribute to early-onset non-communicable diseases, setting the stage for an intergenerational cycle of poor health outcomes.

Emerging literature also points to the presence of nutrition transition within OA populations, marked by a shift from traditional diets to energy-dense, nutrient-poor foods (18-19). This transition occurs within a persistent context of poverty, geographic isolation, and restricted access to health-promoting infrastructure (5-6). For example, a study among OA mother–child dyads near the Krau Wildlife Reserve found that higher maternal education and lower per capita household income (below USD 29.01) significantly increased the odds of an overweight mother–stunted child dyad, while higher household size was inversely associated with the overweight mother–underweight child phenotype (13). Such intrahousehold dualities reflect complex nutritional dynamics and challenge conventional linear models of malnutrition in indigenous settings.

Despite increasing awareness of the DBM among OA communities, empirical research examining the co-occurrence of these nutritional extremes, particularly at the individual level remains scarce. To date, no published study has investigated the DBM among OA children in Terengganu. Furthermore, little is known about how biological factors such as birth weight, alongside socio-demographic variables including household composition and parental characteristics, may influence the emergence of DBM within these communities. Hence, this study aims to address these knowledge gaps by determining the prevalence of undernutrition, overnutrition, and their coexistence among under-five OA children in Terengganu, and by identifying associated biological and socio-demographic correlates. Findings are expected to inform the development of contextually relevant, equity-sensitive nutrition interventions, ultimately contributing to the reduction of health disparities among Malaysia's indigenous populations.

MATERIALS AND METHODS

Study design and location

This study adopted a cross-sectional design and was carried out in two purposively selected Orang Asli (OA) settlements in Terengganu, Malaysia: Kampung Sungai Berua and Kampung Sungai Pergam. Kampung Sungai Berua is situated in the Hulu Terengganu district, while Kampung Sungai Pergam is located in the Kemaman district. These two settlements were selected from three officially recognised OA settlements in Terengganu because both are predominantly inhabited by the Semaq Beri, a sub-tribe of the Senoi ethnic group, which is one of the three main tribal divisions of the OA population in Peninsular Malaysia. Furthermore, considerations of accessibility, community size, and cooperation from local leaders were taken into account to ensure the feasibility of data collection.

Study participants, sampling methods and sample size

This study targeted all Orang Asli (OA) children aged 6 to 59.9 months residing in two selected settlements—Kampung Sungai Berua and Kampung Sungai Pergam—in Terengganu, Malaysia. Eligibility criteria included permanent residence in the study sites, absence of congenital anomalies or physical disabilities, and provision of informed consent by a parent or legal guardian. In households with more than one eligible child, all were included to ensure comprehensive representation of the target age group.

According to official records from the Department of Orang Asli Development (Jabatan Kemajuan Orang Asli, JAKOA), there were a total of 304 registered households across the two settlements. Given the relatively small and geographically dispersed OA population in Terengganu, a purposive sampling strategy was employed. Door-to-

door visits were conducted in all OA households within the two targeted settlements to identify and recruit eligible respondents. This direct engagement strategy facilitated accurate household enumeration, on-site eligibility screening, and informed consent acquisition.

A sample size of 96 respondents was determined based on 95% confidence level, an estimated prevalence of undernutrition among OA children (stunting, underweight and wasting) ranging from 28.2% to 52.0%, and a 10% margin of error. During on-site enumeration, only 171 households were physically identified. The remaining 133 households were not traceable, primarily due to seasonal migration to palm oil plantations or forest areas for subsistence work, or because the households were found to be no longer in existence. Of the 171 identified households, 87 were excluded as they did not have any children within the target age range. Ultimately, 96 eligible children were recruited from 84 households. Of these, 94 children successfully completed the assessment, resulting in a response rate of 97.9%. Although the final sample size was slightly below the calculated estimate, it remains within an acceptable range for the stated precision and confidence level, thereby providing adequate statistical power to detect meaningful prevalence estimates for this study population.

Data collection

From September to December 2023, data were collected in Kampung Sungai Berua and Kampung Sungai Pergam via house-to-house visits. Data were collected using a pre-tested, interviewer-administered questionnaire in the Malay language. Demographic and socio-economic data were obtained from the child's parent or legal guardian. These included: 1) Child characteristics: sub-tribe, residence area, gender, age, birth weight, and types of delivery; 2) Parental characteristics: marital status, education level, occupation; and 3) Household characteristics: number of household members, number of under five children, and monthly household income. The questionnaire was reviewed by experts for content validity and pilot-tested to ensure reliability, clarity, and contextual relevance.

Children's nutritional status was assessed through anthropometric measurements of length/height and weight, following standardized procedures and using calibrated equipment as recommended by the World Health Organization (20). For children aged 6 to 24 months, recumbent length and weight were measured using a SECA 374 baby scale equipped with an integrated measuring rod (SECA 233, SECA GmbH, Germany). For children aged 24 to 59.9 months, standing height was measured using a SECA 213 portable stadiometer, and weight was assessed using a SECA digital weighing scale. Length/height was measured to the nearest 0.1 cm, and weight to the nearest 0.01 kg. All measurements were taken twice, and the average value was recorded.

Anthropometric indices were generated using the WHO Anthro software (Version 3.2.2, 2009), including length/height-for-age z-scores (L/HAZ), weight-for-age z-scores (WAZ), weight-for-length/height z-scores (WL/HZ), and body mass index-for-age z-scores (BAZ). Nutritional status classifications were based on the WHO Child Growth Standards (21). Children with z-scores below -2 standard deviations (SD) were categorized as undernourished—specifically stunted, underweight, or wasted—while those with z-scores above +2 SD were classified as overweight. Overall nutritional status was further classified into four mutually exclusive categories to capture coexistence of multiple forms of malnutrition at the individual level: undernutrition, overnutrition, double burden of malnutrition (DBM), and normal (23-24). Children were classified as experiencing "undernutrition" if they exhibited at least one indicator of undernutrition (stunting, underweight, wasting or thinness). Conversely, children whose measurements indicated overweight or obesity were classified as "overnutrition". When a child simultaneously exhibited indicators of both undernutrition (stunting) and overnutrition (overweight or obese), they were considered to be experiencing the "double burden of malnutrition (DBM)" (19). Children were classified as "normal" if they fell within the normal range for all four indicators of L/HAZ, WAZ, WL/HZ and BAZ (including those at risk overweight).

Ethical consideration

Ethical approval for this study was obtained from the UniSZA Human Research Ethics Committee (UHREC/UniSZA/2023/541) prior to data collection. Permission to conduct the study was also granted by the Department of Orang Asli Development (JAKOA), with further consent and support from local JAKOA officers and the Tok Batin (village head) of each settlement. Written informed consent was obtained from all parents or legal guardians of participating children. Upon completion of the questionnaire and anthropometric measurements, respondents were given a token of appreciation.

Statistical analysis

Data were analysed using IBM SPSS Statistics for Windows, version 26.0. Prior to analysis, the dataset underwent thorough cleaning, and normality of continuous variables was assessed. Descriptive statistics were reported accordingly: normally distributed continuous variables were presented as mean ± standard deviation, non-normally distributed variables as median and interquartile range (IQR), and categorical variables as frequencies and percentages.

To examine factors associated with undernutrition and overnutrition among under-five Orang Asli (OA) children, binary logistic regression analyses were conducted. Children with normal anthropometric status—based on length/height-for-age (L/HAZ), weight-for-age (WAZ), weight-for-length/height (WL/HZ), or BMI-for-age

(BAZ)—were used as the reference group. Univariate logistic regression was first applied to explore the crude association between each independent variable and the nutritional outcomes. Results were presented as crude odds ratios (COR) with corresponding 95% confidence intervals (CI). Variables with a p-value < 0.25 in the univariate analysis, along with variables deemed conceptually or empirically important for confounding control, were included in the multivariable models. A forward likelihood ratio (LR) multiple logistic regression model was employed to derive the final model, with adjusted odds ratios (AOR) and 95% CIs reported. Model assumptions were assessed, including independence of observations, absence of multicollinearity, and linearity of the logit for continuous independent variables. Model adequacy and discrimination was assessed using the Hosmer-Lemeshow goodness-of-fit test, Nagelkerke R^2 and the area under the receiver operating characteristic (ROC) curve. Statistical significance was set at $P < 0.05$.

RESULTS

Demographic and socio-economic characteristics

In this study, the majority of respondents were from the Semaq Beri sub-tribe (75.5%), aged 36 to 59.9 months (57.4%), and resided in Kampung Sungai Berua (53.2%). Nearly one-quarter (22.3%) were of low birth weight, and 17.0% were born prematurely (Table I). Most fathers (58.5%) and mothers (64.9%) were aged 20 to 29 years, with a high proportion of parents being married (92.6%). In terms of educational attainment, 58.5% of fathers and 73.4% of mothers had received only primary or lower secondary education. Fathers were predominantly engaged in traditional subsistence activities, particularly as hunter-gatherers (51.1%), while most mothers were housewives (84.0%) (Table I). Households were typically large (four or more members, 64.9%), with a single under-five child (74.5%), and the vast majority (92.6%) reported monthly incomes below RM 2,560.00 (Table I).

Nutritional status

Based on height-for-age, 42.6% of respondents were classified as stunted. Using the weight-for-age indicator, nearly one-third were underweight, while 5.3% were overweight. For weight-for-length/height, 7.4% were wasted and 8.5% were overweight. According to body mass index-for-age, 5.3% were thin, 4.3% overweight, and 6.4% obese. Overall, 46.8% of respondents exhibited some form of undernutrition, and 7.4% were classified as malnourished. A small proportion (2.1%) showed evidence of the double burden of malnutrition, presenting concurrent undernutrition and overnutrition within the same individual (Table II).

Factor associated with undernutrition and overnutrition among under-five children

Univariate logistic regression revealed that birth weight was significantly associated with undernutrition, while

Table I: Demographic and socio-economic characteristics among under-five indigenous (*Orang Asli*) children (*n* = 94)

Demographic and Socio-economic Characteristics	*n* (%)		
	Boys (*n* = 53)	Girls (*n* = 41)	Total (*n* = 94)
Child Characteristics			
Sub-tribes			
Semaq Beri	41 (77.4)	30 (73.2)	71 (75.5)
Jakun	9 (17.0)	9 (22.0)	18 (19.1)
Temiar	3 (5.7)	2 (4.9)	5 (5.3)
Residence area			
Kampung Sungai Berua	29 (54.7)	21 (51.2)	50 (53.2)
Kampung Sungai Pergam	24 (45.3)	20 (48.8)	44 (46.8)
Age (months)			
6 to 8.9	3 (5.7)	6 (14.6)	9 (9.6)
9 to 11.9	2 (3.8)	0 (0.0)	2 (2.1)
12 to 23.9	8 (15.1)	6 (14.6)	14 (14.9)
24 to 35.9	13 (24.5)	2 (4.9)	15 (16.0)
36 to 47.9	9 (17.0)	10 (24.4)	19 (20.2)
48 to 59.9	18 (34.0)	17 (41.5)	35 (37.2)
Birth weight (kg) (*mean* ± *SD*)	2.78 ± 0.53	2.80 ±0.47	2.79 ± 0.50
Low (< 2.5)	12 (22.6)	9 (22.0)	21 (22.3)
Normal (2.5 to 4.0)	40 (75.5)	31 (75.6)	71 (75.5)
Excessive (> 4.0)	1 (1.9)	1 (2.4)	2 (2.1)
Types of birth			
Pre-term (< 37 weeks)	8 (15.1)	8 (19.5)	16 (17.0)
Full-term (37 weeks and above)	45 (84.9)	33 (80.5)	78 (83.0)
Parental Characteristics			
Paternal age (years)			
< 20	1 (1.9)	0 (0.0)	1 (1.1)
20 to 29	33 (62.3)	22 (53.7)	55 (58.5)
30 to 39	11 (20.8)	11 (26.8)	22 (23.4)
40 to 49	6 (11.3)	3 (7.3)	9 (9.6)
Not available	2 (3.8)	5 (12.2)	7 (7.4)
Paternal marital status			
Married	51 (96.2)	36 (87.8)	87 (92.6)
Divorced	2 (3.8)	2 (4.9)	4 (4.3)
Passed away	0 (0.0)	2 (4.9)	2 (2.1)
Not available	0 (0.0)	1 (2.4)	1 (1.1)
Paternal education level			
No education	10 (18.9)	9 (22.0)	19 (20.2)
Primary education	21 (29.6)	10 (24.4)	31 (33.0)
Lower secondary education	16 (30.2)	8 (19.5)	24 (25.5)
Upper secondary education	4 (7.5)	9 (22.0)	13 (13.8)
Not available	2 (3.8)	5 (12.2)	7 (7.4)
Paternal occupation			
Hunter-gatherer	29 (54.7)	19 (46.3)	48 (51.1)
Palm oil plantation worker	16 (30.2)	12 (29.3)	28 (29.8)
Rubber tapper	1 (1.9)	2 (4.9)	3 (3.2)
Farmer	1 (1.9)	0 (0.0)	1 (1.1)
Fishmonger	0 (0.0)	1 (2.4)	1 (1.1)
Car wash worker	0 (0.0)	1 (2.4)	1 (1.1)
Welding worker	0 (0.0)	1 (2.4)	1 (1.1)
Mechanic worker	2 (3.8)	0 (0.0)	2 (2.1)
Security guard	2 (3.8)	0 (0.0)	2 (2.1)
Not available	2 (3.8)	5 (12.2)	7 (7.4)

continue.....

Table I: Demographic and socio-economic characteristics among under-five indigenous (*Orang Asli*) children (*n* = 94) Continued

Demographic and Socio-economic Characteristics	*n* (%)		
	Boys (*n* = 53)	Girls (*n* = 41)	Total (*n* = 94)
Maternal age (years)			
< 20	2 (3.8)	4 (9.8)	6 (6.4)
20 to 29	33 (62.3)	28 (68.3)	61 (64.9)
30 to 39	17 (32.1)	9 (22.0)	26 (27.7)
40 to 49	1 (1.9)	0 (0.0)	1 (1.1)
Maternal marital status			
Married	51 (96.2)	36 (87.8)	87 (92.6)
Divorced	2 (3.8)	2 (4.9)	4 (4.3)
Widower	0 (0.0)	2 (4.9)	2 (2.1)
Single	0 (0.0)	1 (2.4)	1 (1.1)
Maternal education level			
No education	2 (3.8)	1 (2.4)	3 (3.2)
Primary education	16 (30.2)	11 (26.8)	27 (28.7)
Lower secondary education	25 (47.2)	17 (41.5)	42 (44.7)
Upper secondary education	10 (18.9)	12 (29.3)	22 (23.4)
Maternal occupation			
Housewife	46 (86.8)	33 (80.5)	79 (84.0)
Palm oil plantation worker	5 (9.4)	5 (12.2)	10 (10.6)
Rubber tapper	1 (1.9)	0 (0.0)	1 (1.1)
Farmer	1 (1.9)	0 (0.0)	1 (1.1)
Fishmonger	0 (0.0)	1 (2.4)	1 (1.1)
Restaurant worker	0 (0.0)	1 (2.4)	1 (1.1)
Hunter-gatherer	0 (0.0)	1 (2.4)	1 (1.1)
Household Characteristics			
Household size (person)			
< 4	19 (35.8)	14 (34.1)	33 (35.1)
4 to 5	22 (41.5)	16 (39.0)	38 (40.4)
> 5	12 (22.6)	11 (26.8)	23 (24.5)
Number of under-five children			
1	43 (81.1)	27 (65.9)	70 (74.5)
2	10 (18.9)	14 (34.1)	24 (25.5)
Household income group			
B1 (< RM 2560.00)	48 (90.6)	39 (95.1)	87 (92.6)
B2 (RM 2560.00 to 3439.00)	5 (9.4)	1 (2.4)	6 (6.4)
B3 (RM 3440.00 to 4309.00)	0 (0.0)	0 (0.0)	0 (0.0)
B4 (RM 4310.00 to 5249.00)	0 (0.0)	1 (2.4)	1 (1.1)

Not available: Paternal data unavailable due to father's death and divorced or single mother household;
Household income group was based on the Household Income and Basic Amenities Survey Report 2022 [22]

both birth weight and the number of under-five children in the household were significantly associated with overnutrition (Tables III and IV). In the multiple logistic regression model, birth weight remained independently associated with both undernutrition and overnutrition. Specifically, higher birth weight was inversely related to the likelihood of undernutrition, with an adjusted odds ratio (AOR) of 0.30 (95% CI: 0.10, 0.87; p = 0.026). Conversely, increased birth weight was positively associated with overnutrition, with an AOR of 14.98 (95% CI: 1.88, 119.35; p = 0.011) (Tables III and IV).

DISCUSSION

Consistent with the findings from other sub-tribes across

Table II: Nutritional status among under-five indigenous (*Orang Asli*) children (*n* = 94)

Nutritional Status	*n* (%)		
	Boys (*n* = 53)	Girls (*n* = 41)	Total (*n* = 94)
Length/height-for-age, L/HAZ (*mean* ± *SD*)	**-2.03 ± 1.20**	**-1.85 ± 0.90**	**-1.95 ± 1.08**
Severe stunting (< -3.0 SD)	11 (20.8)	3 (7.3)	14 (14.9)
Moderate stunting (-3.0 to < -2.0 SD)	15 (28.3)	11 (26.8)	26 (27.7)
Normal (-2.0 to 2.0 SD)	27 (50.9)	27 (65.9)	54 (57.4)
Weight-for-age, WAZ (*mean* ± *SD*)	**-1.22 ± 1.51**	**-1.37 ± 1.18**	**-1.29 ± 1.37**
Severe underweight (< -3.0 SD)	3 (5.7)	2 (4.9)	5 (5.3)
Moderate underweight (-3.0 to < -2.0 SD)	16 (30.2)	8 (19.5)	24 (25.5)
Normal (-2.0 to 2.0 SD)	30 (56.6)	30 (73.2)	60 (63.8)
Overweight (> 2.0 SD)	4 (7.5)	1 (2.4)	5 (5.3)
Weight-for-length/height, WL/HZ (*mean* ± *SD*)	**-0.12 ± 1.69**	**-0.39 ± 1.28**	**-0.24 ± 1.52**
Severe wasting (< -3.0 SD)	0 (0.0)	0 (0.0)	0 (0.0)
Moderate wasting (-3.0 to < -2.0 SD)	4 (7.5)	3 (7.3)	7 (7.4)
Normal (-2.0 to < 1.0 SD)	40 (75.5)	34 (82.9)	74 (78.7)
At risk overweight (1.0 to 2.0 SD)	4 (7.5)	1 (2.4)	5 (5.3)
Overweight (> 2.0 SD)	5 (9.4)	3 (7.3)	8 (8.5)
Body mass index-for-age, BAZ (*mean* ± *SD*)	**0.14 ± 1.65**	**-0.31 ± 1.32**	**-0.06 ± 1.52**
Severe thinness (< -3.0 SD)	0 (0.0)	0 (0.0)	0 (0.0)
Moderate thinness (-3.0 to < -2.0 SD)	2 (3.8)	3 (7.3)	5 (5.3)
Normal (-2.0 to < 1.0 SD)	41 (77.4)	33 (80.5)	74 (78.7)
At risk overweight (1.0 to 2.0 SD)	4 (7.5)	2 (4.9)	6 (6.4)
Overweight (> 2.0 to 3.0 SD)	2 (3.8)	2 (4.9)	4 (4.3)
Obese (> 3.0 SD)	4 (7.5)	1 (2.4)	6 (6.4)
Overall			
Undernutrition	26 (49.1)	18 (43.9)	44 (46.8)
Normal	21 (39.6)	20 (48.8)	41 (43.6)
Overnutrition	4 (7.5)	3 (7.3)	7 (7.4)
Double-burden of malnutrition	2 (3.8)	0 (0.0)	2 (2.1)

L/HAZ, WAZ, WL/HZ and BAZ are presented in z-score;
Undernutrition: At least one form of undernutrition of stunting/underweight/wasting/thinness; **Overnutrition:** Overweight or obese; **Normal:** Normal for all four indicators of L/HAZ, WAZ, WL/HZ and BAZ (including those at risk overweight); **Double-burden of malnutrition:** The coexistence of undernutrition (stunting) and overnutrition (overweight or obesity) within individual.

Peninsular Malaysia (10, 12-14), the present study reinforces the growing concern over the double burden of malnutrition (DBM) among Orang Asli (OA) children under-five. This phenomenon, where undernutrition coexists with rising rates of overnutrition, reflects a critical public health paradox in marginalised indigenous communities undergoing rapid social, economic, and dietary changes.

Our findings provide compelling evidence of this dual nutritional burden among OA children in Terengganu, with 46.8% experiencing at least one form of undernutrition, 7.4% were classified as overnourished, and 2.1% concurrently exhibited both conditions. The prevalence of stunting (42.6%) and underweight (30.8%) was particularly alarmingly, indicating chronic nutritional deprivation and the cumulative effects of poverty, ecological marginalisation, and limited access

Table III: Binary logistic regression on the factor associated with undernutrition among under-five Orang Asli (OA) children

Characteristics	COR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
Birth weight (kg)	0.30 [0.10, 0.87]	0.026*	0.30 [0.10, 0.87]	0.026*
Paternal occupation				
Hunter-gatherer	2.08 [0.83, 5.20]	0.119	_	
Others	1			
Not available	1.95 [0.37, 10.20]	0.429		
Maternal occupation				
Housewife	2.81 [0.79, 9.98]	0.109	_	
Others	1			
No. of under-five children				
1	2.62 [0.88, 7.82]	0.084	_	
2 and above	1			

Forward LR multiple logistic regression model was applied; Nagelkerke *R* (0.085); Hosmer-Lemeshow test (0.051); Classification table (overall correctly classified percentage = 60.0%); Area under the ROC curve (62.9%, p = 0.041) were applied to check model fit.
* $p < 0.05$; Undernutrition ($n = 44$); Normal nutritional status ($n = 41$) as reference group for dependent variable;
"_" for AOR (95% CI) reflects variables excluded from the final model following the Forward LR multiple logistic regression procedure.

Table IV: Binary logistic regression on the factor associated with overnutrition among under-five Orang Asli (OA) children

Characteristics	COR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
Birth weight (kg)	14.98 [1.88, 119.35]	0.011*	14.98 [1.88, 119.35]	0.011*
Paternal education				
No to primary education	0.32 [0.06, 1.88]	0.209	_	
Secondary education	1			
Household size (person)	1.47 [0.87, 2.50]	0.151	_	
No. of under-five children				
1	0.17 [0.03, 0.97]	0.047*	_	
2 and above	1			
Household income (RM/month)				
< RM 2560.00	0.20 [0.03, 1.48]	0.115	_	
RM 2560.00 and above	1			

Forward LR multiple logistic regression model was applied; Nagelkerke *R (0.294);* Hosmer-Lemeshow test (0.803); Classification table (overall correctly classified percentage = 91.7%); Area under the ROC curve (77.0%, p = 0.024) were applied to check model fit.
* $p < 0.05$; ** $p < 0.01$; Overnutrition ($n = 7$); Normal nutritional status ($n = 41$) as reference group for dependent variable;
"_" for AOR (95% CI) reflects variables excluded from the final model following the Forward LR multiple logistic regression procedure.

to quality health services. At the same time, 10.7% were overweight or obese, reflecting an increasing intrusion of obesogenic environments, even in traditionally deprived settings. These findings align closely with national surveillance data on OA children, which reported 43.8% stunting, 32.9% underweight, 11.6–12.3% wasting, and 7.4% overweight (3), thus supporting the representativeness of the current sample.

Compared to national-level estimates from the National Health and Morbidity Survey (NHMS 2022)—which reported 21.2% stunting and 15.3% underweight among Malaysian children under five— the substantially higher rates of undernutrition observed among OA children in Terengganu (2). This highlights persistent health inequities that reflect persistent structural determinants, such as poor access to health and nutrition services, chronic food insecurity, poor water and sanitation infrastructure, and low maternal education (4-7, 9). In addition, the emergence of DBM is likely driven by a nutrition transition, whereby traditional dietary patterns are being displaced by high-calorie, nutrient-poor processed products (18, 25). This pattern has been similarly observed among indigenous populations in Australia and the Amazon basin, where sociopolitical marginalisation and environmental transitions contribute to the increases in obesity and nutrition-related diseases (26-27).

Importantly, birth weight emerged as a significant factor of both under- and overnutrition. Children with higher birth weight were significantly less likely to be undernourished, yet they exhibited increased odds of being overnourished. While this large effect size may partly reflect data sparsity given the small number of overnourished children, the direction of association is biologically plausible. These findings align with the Developmental Origins of Health and Disease (DOHaD) hypothesis, which posits that early-life growth trajectories—shaped by intrauterine and perinatal exposures—critically influence long-term health and nutritional outcomes (28-29). Specifically, low birth weight reflects intrauterine nutritional compromise and has consistently been linked to stunting, as also observed in OA preschool children in Negeri Sembilan (AOR: 2.53, 95% CI: 1.31, 4.87) (7). Conversely, higher birth weight may predispose individuals to later overweight and metabolic risks, particularly in settings where postnatal catch-up growth occurs in parallel with exposure to obesogenic environments (30-31). This pattern has also been substantiated in local research. These findings highlight the dual role of birth weight as both a marker of neonatal health, and a critical determinant of future nutritional vulnerability. Nonetheless, given the limited number of overnourished children in this study, the findings of this study should be regarded as exploratory and interpreted with caution.

From a policy perspective, these results advocate for integrated nutrition programming targeting both ends of the malnutrition spectrum. Priority strategies should include: (i) improved maternal and antenatal care to reduce the incidence of low birth weight; (ii) targeted nutrition education for caregivers; and (iii) the

development of culturally tailored dietary interventions that support indigenous food systems while limiting the penetration of ultra-processed products.

Despite its strengths, the study has several limitations. The cross-sectional design limits causal interpretation, while the purposive sampling strategy may limit the generalisability of findings to all OA communities in Peninsular Malaysia. Furthermore, the small number of children classified as overnourished limits statistical power and the precision of the estimates, making the results exploratory than conclusive. Future research should adopt larger-scale samples and employ longitudinal or mixed-methods designs to better understand the temporal and sociocultural pathways through which biological, environmental, and socioeconomic factors influence malnutrition outcomes. Finally, there are limitations in the operational definition of overall nutritional status at the individual level: (1) children classified as 'at risk of overweight' were grouped under 'normal,' potentially masking early signs of excess weight gain; and (2) the four-category classification may mask subtler nutritional risks, as a child categorised as "normal" could still present risk when individual indices (e.g. WAZ or BAZ) are considered separately. Nonetheless, this study is the first to document the prevalence and factors associated with both undernutrition and overnutrition among under-five OA children in Terengganu. It provides valuable empirical insights into the nutritional double burden in a uniquely vulnerable population, and offers evidence-based direction for developing contextually relevant, equity-oriented interventions.

CONCLUSION

This study shows that under-five Orang Asli (OA) children in Terengganu are experiencing both undernutrition and overnutrition, reflecting the double burden of malnutrition. Nearly half of the children were undernourished, while a growing number were overweight or obese. Some children even showed signs of both conditions at the same time. Birth weight was found to be a key factor in predicting nutritional outcomes. This highlights the importance of early-life conditions in shaping long-term health.

These findings point to the urgent need for targeted public health strategies that address both types of malnutrition. Interventions should include improved maternal care, culturally appropriate nutrition education, and better access to nutritious foods. Policies must also tackle the broader social and environmental challenges faced by OA communities.

ACKNOWLEDGEMENTS

This research was supported by Universiti Sultan Zainal Abidin (UniSZA) through the Dana Penyelidikan Universiti 1.0 scheme (UniSZA/2022/DPU1.0/39). The authors extend their sincere gratitude to the Department of Orang Asli Development (JAKOA), the local community leaders (Tok Batin), field enumerators, and research assistants for their essential support throughout the study. Special appreciation is also given to all participating caregivers and children for their time, trust, and invaluable contributions.

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