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# Demographic, socioeconomic and dietary factors are associated with double burden of malnutrition among indigenous communities in Sarawak

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## ABSTRACT

**Introduction:** Double burden of malnutrition (DBM), encompassing both overnutrition and undernutrition, is a growing global public health issue. Indigenous people are one of the marginalised populations experiencing DBM at varying severity. This study aimed to identify factors contributing to DBM in indigenous households in Sarawak. **Methods:** This cross-sectional study utilised multistage random sampling to include 286 indigenous households from six administrative divisions in Sarawak. Mothers aged 20–49 years who had at least one child aged 2–12 years were recruited. Trained interviewers obtained information on demographic and socioeconomic characteristics, food security, and dietary intake via a two-day, 24-hour dietary recall. Height and weight measurements followed World Health Organization protocols. DBM household was identified as having an overnourished (overweight/obese) mother with an undernourished (underweight/stunting/wasting) child within the same household. Simple and multiple binary logistic regression analyses were performed. **Results:** Prevalence of DBM among the indigenous communities in Sarawak was 25.2%. Households with an overweight/obese mother and a stunted child was 12.9%, wasted child (11.9%), and underweight child (9.4%). Households with younger mothers, a household size of >4 persons, and higher income per capita (relative to sample population) were significantly more likely to have DBM. Conversely, households with higher monthly non-food expenditure and greater fish and seafood intake scores in children were significantly less likely to have DBM. **Conclusion:** DBM is prevalent among Sarawak's indigenous communities, affecting 25.2% of households. Further research and targeted interventions are needed to address socioeconomic and dietary factors in these populations.

**Keywords:** dietary, indigenous, malnutrition, Sarawak, stunting

## INTRODUCTION

Malnutrition has persisted in various countries worldwide, with an emerging and increasing prevalence of double burden of malnutrition (DBM) in recent years. While there are many operational definitions for DBM, it is generally understood as the coexistence of overnutrition and undernutrition throughout one's life that occurs at the individual, household, or population levels (Popkin, Corvalan & Grummer-

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Strawn, 2020). Data analysis from lower to middle-income countries (LMIC) from the 1990s and 2010s estimated that 37% of countries were experiencing DBM based on a 20% overweight prevalence cut-off, predominantly in Asia (Popkin *et al.*, 2020). At the household level, DBM prevalence ranged from 3–35%, often consisting of overweight or obese mothers and a stunted child (Popkin *et al.*, 2020).

DBM is particularly prevalent among marginalised populations at varying severity, such as the indigenous people, which is observed at the population and household levels. In Guatemala, the prevalence of stunting in children was 63.7%, while overweight in women was 46.7% among the indigenous population (Ramirez-Zea *et al.*, 2014). In Xavante villages in Brazil, stunting (16.1%) was observed among children <10 years, of which 20.3% were females and 11.8% were males (Welch *et al.*, 2020). Almost half of the villagers (49.8%) aged >18 years were overweight (Welch *et al.*, 2020).

In Malaysia, studies have reported on the nutritional status among the indigenous (*Orang Asli*) communities in Peninsular Malaysia, highlighting the presence of undernutrition in children and overnutrition in adults (Chong, Appannah & Sulaiman, 2019; Saibul *et al.*, 2009; Tay *et al.*, 2022; Wong *et al.*, 2015). Two studies examined DBM at the household level, particularly between mother-child pairs. In 2009, Saibul *et al.* (2009) revealed that 25.8% of households had an overweight or obese mother with an underweight child aged 2–9 years. Meanwhile, Wong *et al.* (2015) reported that 20% of households had overweight or obese mothers with an underweight or stunted child under five years. A study performed among the Penan tribe in Sarawak reported that the nutritional status of infants and young children (<2 years) were 29.8%, 43.0%, and 5.8% for underweight, stunting, and wasting, respectively (Bong, Karim & Noor, 2018). Chang *et al.* (2016) reported that approximately 40% of Sarawakian indigenous adults were overweight and obese.

Despite the adverse outcomes of DBM, including high risk of non-communicable diseases (NCDs) and low economic productivity in affected countries (ECLAC & WFP, 2017), information concerning DBM household status remains scarce, particularly among the indigenous communities in Sarawak. As health disparities are more apparent in indigenous people (Ramirez-Zea *et al.*, 2014), there is an urgent need to assess the nutritional status of these communities, which make up a majority of the state's population. This study, which defined DBM as a household with an overweight or obese mother and an undernourished child (underweight, stunting, or wasting) aimed to identify household-level DBM and its associated factors among the indigenous communities in Sarawak.

## MATERIALS AND METHODS

### Sampling

This cross-sectional study focused on the indigenous communities in Sarawak. A multistage random sampling was used to randomly select six administrative divisions: Kuching, Samarahan, Serian, Sibu, Sarikei, and Miri. Subsequently, a representative district from each division was randomly selected; a list of longhouses and villages in these locations was obtained from the respective local councils. Likewise, the longhouses and villages were randomly selected using a random number generator.

The sample size for this study was estimated using Daniel's (2012) formula: $Z^2p(1-p)/d^2$. A previous study estimated the prevalence of DBM in households with overweight/obese mothers and

underweight/stunted children among indigenous people (*Orang Asli*) to be 20.0% (Wong *et al.*, 2015); thus, 246 households were required for this study. A non-response rate of 10.0% was estimated for pilot testing. As data collection was performed during the movement control order (MCO) due to the COVID-19 pandemic, the non-response rate was increased to 20.0%. Therefore, the final sample size was calculated, considering a 20.0% non-response rate, yielding a final sample size of 296.

**Study participants**

Mother-child pairs were recruited from households within the selected longhouses and villages. The inclusion criteria were indigenous women aged 20 – 49 years with at least one child aged 2 – 12 years. While the World Health Organization (WHO) described women of reproductive age as those ranging from 15 – 49 years old, the female participants selected for this study were 20 – 49 years old, as this group had more autonomy in decision-making, improving the reliability of their food security information. Additionally, women in this age group were predominantly involved in obtaining and preparing food and, thus, were more familiar with the food supply within their households. Meanwhile, physically or mentally disabled women and those who were pregnant and breastfeeding were excluded from this study. If a mother had more than one child aged 2 – 12 years within a household, one child was randomly selected to be included in this study. Numbers were assigned to each eligible child and a random number generator was used to select a child for this study. When the randomly selected child was absent, another child present during the recruitment process was chosen randomly, and their height and weight were recorded.

**Ethical approval and permission**

The ethical approval for this study was granted by the Medical Ethics Committee of the Faculty of Medicine and Health Sciences, Universiti Malaysia Sarawak (FME/21/13). Approvals from the local councils of selected districts were also obtained prior to conducting the research. Furthermore, heads of villages and longhouses were contacted for permission to conduct the study. Participants were briefed on the purpose of the study and asked to sign informed consent forms before participating.

**Data collection**

The village chiefs (*Ketua Kampung*) and longhouse leaders (*Tuai Rumah*) were briefed about the research before data collection. They helped relay the information to the residents to improve their willingness to participate in this study. Questionnaires were interviewer-administered by trained local enumerators, followed by measurements of mothers' and children's height and weight according to WHO standard protocols (WHO, 2006).

**Demographic and socioeconomic characteristics**

Data collected from mothers included their age, household size, level and duration of education, occupation, number of children, household income, and monthly household expenses on food and non-food items. In addition, children's age, sex, and birth weight information were also obtained. Monthly household income was classified using the mean Poverty Line Income (PLI) in Sarawak for an average household size of four persons (DOSM, 2020). A monthly household income per capita of less than RM286 was classified as hardcore poverty, whereas those with an income below RM568 were considered poor (DOSM, 2020).

**Table 1.** Demographic and socioeconomic characteristics and food security status of selected indigenous households in Sarawak (*N*=286)

| *Variables* | *n* | *%* | *Mean±SD* |
|---|---|---|---|
| Age (years) | | | 34.7±6.8 |
| 20 – 29 | 70 | 24.5 | |
| 30 – 39 | 142 | 49.7 | |
| 40 – 49 | 74 | 25.9 | |
| Ethnicity | | | |
| Iban | 104 | 36.4 | |
| Bidayuh | 151 | 52.8 | |
| Others† | 31 | 10.8 | |
| Marital status | | | |
| Married | 264 | 92.3 | |
| Divorced/separated/widowed | 22 | 7.7 | |
| Household size | | | 5±1 |
| ≤4 | 104 | 36.4 | |
| >4 | 182 | 63.6 | |
| Education of mother (years) | | | 10.5±3.1 |
| No formal education | 11 | 3.8 | |
| Primary school | 20 | 7.0 | |
| Secondary school | 216 | 75.5 | |
| Tertiary education | 39 | 13.6 | |
| Education of spouse (years) | | | 9.7±3.7 |
| No formal education | 4 | 1.4 | |
| Primary school | 30 | 10.5 | |
| Secondary school | 196 | 68.5 | |
| Tertiary education | 34 | 11.9 | |
| Passed away or divorced | 22 | 7.7 | |
| Occupation of mother | | | |
| Employed | 82 | 28.7 | |
| Housewife | 204 | 71.3 | |
| Occupation of spouse | | s | |
| Employed | 255 | 89.2 | |
| Others (retired/passed away/divorced/ unemployed) | 31 | 10.8 | |
| Household income per capita (MYR)‡ | | | 333.3 |
| Hardcore poor (<286) | 105 | 36.7 | |
| Poor (<568) | 124 | 43.4 | |
| Normal (≥568) | 57 | 19.9 | |
| Expenses on food and beverages (MYR) | | | 900 |
| Expenses on non-food items (MYR) | | | 604.5 |

**Table 1.** Demographic and socioeconomic characteristics and food security status of selected indigenous households in Sarawak (*N*=286) *[continued]*

| *Variables* | *n* | *%* | *Mean±SD* |
|---|---|---|---|
| Children's characteristics | | | |
| Age (years) | | | 7.16±3.13 |
| <5 | 92 | 32.2 | |
| ≥5 | 194 | 67.8 | |
| Gender | | | |
| Male | 144 | 50.3 | |
| Female | 142 | 49.7 | |
| Birth weight (kg) | | | 2.9±0.5 |
| Boys | | | 2.9±0.5 |
| Girls | | | 2.8±0.4 |
| | | | |
| Food security status | | | |
| Food secure | 141 | 49.3 | |
| Food insecure | 145 | 50.7 | |
| Household insecure | 63 | 22.0 | |
| Individual insecure | 42 | 14.7 | |
| Child hunger | 40 | 14.0 | |

MYR: Malaysian Ringgit; USD 1 = MYR 4.55 as of 26 July 2023
[†]Others include Kayan, Kenyah, Melanau, Kedayan and Sebob
[‡]Income category based on the Poverty Line Income (PLI) in Sarawak (DOSM, 2020);

**Food insecurity status**

The Radimer/Cornell Hunger and Food Insecurity Instrument is a ten-item validated tool developed by Radimer *et al.* (1992) to determine the severity of household food insecurity. The instrument used in this study was the validated Malay language version (Sharif & Ang, 2001), as most local communities had satisfactory language proficiency. Cronbach's alpha reliability during the pilot test demonstrated a good coefficient (0.898). The response categories used in the instrument comprised 'not true', 'sometimes true', and 'often true', which were used to categorise a household as food secure (negative response to all items), household food insecure (positive response to any 1 – 4 items), individual food insecure (positive response to any 5 – 7 items) or child hunger (positive response to any 8 – 10 items).

**Dietary intake**

Trained local enumerators performed a two-day, 24-hour dietary recall to obtain information on all foods and beverages the selected mothers and their children had consumed, such as food types, preparation methods, brand names of processed food items, and intake of any dietary supplements. Standard local household utensils (glass, spoon, and plate) were used in these sessions to ensure the participants could accurately estimate the foods consumed. In addition, clarification regarding portion sizes and probes were used to reduce misreporting when participants could not recall the foods they had consumed. Subsequently, the adequacy of total energy and macronutrient intakes for mothers and their children was determined based on the Recommended Nutrient Intakes (RNI) for Malaysia (NCCFN, 2017), followed by a dietary

assessment using the Nutritionist Pro Version 2.4.1 software (Axxya Systems, Stafford, TX, USA).

**Malaysian Healthy Eating Index (M-HEI)**

The M-HEI score is an instrument developed by Lee and colleagues, composing of nine components – seven food groups and two nutrient groups (Lee, Norimah & Safiah, 2011). It was used to assess the mothers' and children's overall diet quality. This instrument was later validated by Goh & Norimah (2012). Each food group score was calculated using the formula: [actual serving consumed based on respondent's diet recall/recommended serving size based on Malaysian Dietary Guidelines (MDG)] × 10. Meanwhile, the nutrient score was calculated proportionately for in-between whole-number responses (0 – 10). MDG recommendations for serving size and nutrient intake were used to reference the component scores. The composite score (%) was subsequently calculated using the formula: (total score obtained from nine components/maximum score of 90) × 100%. Total scores of <51%, 51 – 80%, and >80% were indicated as poor diet, diet requiring improvement, and good diet, respectively (Chong *et al.*, 2019).

**Anthropometric measurements**

Mothers' and children's height and weight were measured following WHO standard protocols. A digital weighing scale (HD-382, Tanita, Japan) and stadiometer 217 (SECA, Germany) were used to measure weight (to the nearest 0.1 kg) and height (to the nearest 0.1 cm), respectively. Subsequently, BMI was calculated and defined based on WHO guidelines. Mother's BMI was classified as follows: underweight (<18.5 kg/m$^2$), normal (18.5 – 24.9 kg/m$^2$), overweight (25.0 – 29.9 kg/m$^2$), and obese (>30.0 kg/m$^2$).

Meanwhile, children were categorised based on age- and sex-specific *z*-scores for height-for-age (HAZ), BMI-for-age (BAZ), and weight-for-age (WAZ) for children aged 2 – 10 years. WHO AnthroPlus software version 1.0.4 (WHO, Geneva, Switzerland) was used for children's nutritional status assessment. A HAZ of < -2 standard deviation (*SD)* was classified as stunted for all children. BAZ for children <5 years was classified as follows: wasted (BAZ < -2*SD*), normal (-2*SD* ≤ BAZ ≤ +2*SD*), overweight (+2*SD* < BAZ ≤ +3*SD*), and obese (BAZ > +3*SD*) (WHO, 2006). Meanwhile, children aged 5 – 12 years were classified as thin (BAZ < - 2*SD*), normal (-2*SD* ≤ BAZ ≤ +1*SD*), overweight (+1*SD* < BAZ ≤ +2*SD*), and obese (BAZ> +2*SD*) (WHO, 2006). In this study, children aged 5 – 12 years who were classified as thin were grouped with those aged <5 years who were categorized as wasted (BAZ < -2*SD*). Furthermore, children aged 2 – 10 years with a WAZ of < -2*SD* were classified as underweight (WHO, 2006).

**Statistical analysis**

Data analysis was performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, New York, United States). Descriptive statistics were presented as mean±*SD*, median and interquartile range (*IQR*), or percentage and frequency. A preliminary analysis was performed to identify DBM (overweight/obese mother with an undernourished child) in different households. Other findings on nutritional status were considered non-DBM. Associations between demographic and socioeconomic characteristics, food insecurity, calorie and macronutrient intakes, and M-HEI component scores with DBM were analysed using simple binary logistic regression. Independent variables that were significant at $p<0.20$ in the simple binary logistic regression were included in the multiple binary logistic regression.

Results were presented as an adjusted odds ratio (*AOR*), with a 95% confidence interval (*CI*). The multicollinearity of the results was also evaluated in this study. Statistical significance was set at $p<0.05$.

## RESULTS

### Demographic and socioeconomic characteristics of households and their food insecurity status

A total of 286 households were included in this study. The mean age of mothers was 34.7±6.8 years, where almost half were in the 30–39 age group. The mothers were predominantly Bidayuh in ethnicity (52.8%), followed by Iban (36.4%). The mean household size was 5±1 persons, with most households (63.6%) comprising >4 individuals. Most mothers (75.5%) and their spouses (68.5%) had secondary education. Based on income per capita, 43.4% of the households were poor (<RM 568), while 36.7% were hardcore poor (<RM 286). The mean age of children was 7.2±3.1 years, where most were 5–12 years old (67.8%) and the rest were <5 years old (32.2%). Most children were boys (50.3%), while the remaining 49.7% were girls. Their mean birth weight was 2.9±0.5 kg. Half of the households (50.7%) were food insecure, with household insecurity (22.0%), individual insecurity (14.7%), and child hunger (14.0%).

### Calorie and macronutrient intakes of households

The calorie and macronutrient intakes of mothers and children are detailed in Table 2. The mean calorie intake of mothers was 1748±309 kcal, with more than half (66.4%) recording a calorie intake below the RNI. In addition, most mothers (77.3%) had inadequate carbohydrate intake, below the 50 – 65% recommended energy intake from carbohydrates. In contrast, mothers recorded adequate mean protein intake (78.1±18.9 g/day), which conformed with the recommended 55 g/day for Malaysian women. Likewise, most mothers (82.5%) achieved the suggested 10–20% protein contribution to total energy intake (TEI). Moreover, most mothers (89.2%) revealed excessive fat intake, where >30% of their energy was sourced from fat, which exceeded the recommended 25–30%.

The mean calorie intake for children was 1360±363 kcal, where more than half of them (62.2%) had inadequate calorie intake. Similar to the mothers, most children (74.8%) had <50% energy from carbohydrate intake. Meanwhile, most children (75.9%) had adequate protein intake, with 10–20% energy contributed from protein. The children's mean protein intake (60.4±19.5 g/day) had achieved the RNI for protein consumption recommended for their age and sex. Conversely, the majority of children (63.6%) had excessive fat intake, where >35% of their energy was contributed from fat intake.

### Malaysian Healthy Eating Index (M-HEI) of indigenous households

The current study discovered that no households in the sample population had a good-quality diet. The mothers (64.0%) and children (94.8%) had generally poor diet quality, with a mean M-HEI composite score of 48.4±7.8% and 36.3±9.6, respectively. Mothers scored the lowest for fruits, legumes, and total fat intake (median scores = 0), followed by milk and milk products (median score = 1.0) and sodium intake (median score = 5.0). Meanwhile, children scored the lowest for fruits, legumes, total fat, and sodium intake (median score = 0), followed by milk and milk products (median score = 1.0), fish and seafood (median score = 2.5), and vegetable intake (median score = 5.0). Notably, the children recorded a full score for the meat, poultry and eggs food group

**Table 2.** Calorie and macronutrient intakes of mothers and children (*N*=286)

| *Calories and macronutrients* | *n (%)* | *Mean±SD* |
|---|---|---|
| Mothers | | |
| Calories (kcal) | | 1748±309 |
| <RNI | 190 (66.4) | |
| ≥RNI | 96 (33.6) | |
| Carbohydrate (g/day) | | 194.3±39.3 |
| Energy from carbohydrate (%) | | 44.6±6.5 |
| <50 % | 221 (77.3) | |
| 50 – 65%† | 65 (22.7) | |
| Protein (g/day) | | 78.1±18.9 |
| Energy from protein (%) | | 17.9±3.4 |
| 10 – 20%† | 236 (82.5) | |
| >20% | 50 (17.5) | |
| Fat (g/day) | | 73.7±20.1 |
| Energy from fat (%) | | 37.5±5.7 |
| <25% | 4 (1.4) | |
| 25 – 30%† | 27 (9.4) | |
| >30% | 255 (89.2) | |
| | | |
| Children | | |
| Calories (kcal) | | 1360±363 |
| <RNI | 178 (62.2) | |
| ≥RNI | 108 (37.8) | |
| Carbohydrate (g/day) | | 149.5±36.1 |
| Energy from carbohydrate (%) | | 44.9±7.5 |
| <50% | 214 (74.8) | |
| 50 – 65%† | 69 (24.1) | |
| >65% | 3 (1.0) | |
| Protein (g/day) | | 60.4±19.5 |
| Energy from protein (%) | | 17.7±3.4 |
| <10% | 4 (1.4) | |
| 10 – 20%† | 217 (75.9) | |
| >20% | 65 (22.7) | |
| Fat (g/day) | | 58.0±22.0 |
| Energy from fat (%) | | 37.4±6.4 |
| <25% | 8 (2.8) | |
| 25 – 35%† | 96 (33.6) | |
| >35% | 182 (63.6) | |

RNI: Recommended Nutrient Intake
†Recommended percentage of macronutrient contribution to total energy intake (NCCFN, 2017)

**Table 3.** Malaysian Healthy Eating Index (M-HEI) of households (*N*=286)

| *M-HEI components* | *Median (IQR)/ Mean±SD* |
|---|---|
| Mothers | |
| Food groups | |
| Grains and cereals | 8.0 (3.1) |
| Vegetables | 10.0 (0.0) |
| Fruits | 0.0 (0.0) |
| Meat, poultry, and eggs | 10.0 (0.0) |
| Fish and seafood | 10.0 (5.0) |
| Legumes | 0.0 (0.0) |
| Milk and milk products | 1.0 (0.5) |
| Nutrients | |
| Total fat (% from total energy intake) | 0.0 (2.0) |
| Sodium (mg) | 5.0 (6.0) |
| Mothers' M-HEI composite score (%) | 48.4±7.8 |
| Poor diet (<51), *n* (%) | 183 (64.0) |
| Diet that requires improvement (51–80), *n* (%) | 103 (36.0) |
| Children | |
| Food groups | |
| Grains and cereals | 6.8 (4.7) |
| Vegetables | 5.0 (6.7) |
| Fruits | 0.0 (1.25) |
| Meat, poultry, and eggs | 10.0 (0.0) |
| Fish and seafood | 2.5 (7.1) |
| Legumes | 0.0 (0.0) |
| Milk and milk products | 1.5 (4.5) |
| Nutrients | |
| Total fat (% from total energy intake) | 0.0 (0.0) |
| Sodium (mg) | 0.0 (7.0) |
| Children's M-HEI composite score (%) | 36.3±9.6 |
| Poor diet (<51), *n* (%) | 271 (94.8) |
| Diet that requires improvement (51–80), *n* (%) | 15 (5.2) |

M-HEI: Malaysian Healthy Eating Index; *IQR* = Interquartile Range

(median score = 10.0) (Table 3).

**Household nutritional status**

Table 4 presents the nutritional status of the indigenous households. DBM prevalence at the household level among the indigenous communities was 25.2% in this study; 12.9% of households recorded the coexistence of an overweight or obese mother with a stunted child (mOver/cStunt), whereas an overweight or obese mother with a wasted child (labelled as mOver/cWasted) was observed in 11.9% of households. Only 235 households were assessed for overweight or obese mothers with underweight children because WAZ reference data was unavailable for children >10 years old. Therefore, approximately 9.4% of households had an overweight or obese mother with an underweight child (mOver/cUnder) among the indigenous communities in Sarawak.

**Table 4.** Nutritional status of mothers and children (*N*=286)

| *Characteristics* | *n* | *%* | *Mean±SD* |
|---|---|---|---|
| Mothers | 286 | | |
| Weight (kg) | | | 69.2±15.2 |
| Height (cm) | | | 153.0±5.4 |
| BMI (kg/m$^2$) | | | 29.6±6.2 |
| Underweight (<18.50) | 5 | 1.7 | |
| Normal (18.50 – 24.99) | 56 | 19.6 | |
| Overweight (25.00 – 29.99) | 111 | 38.8 | |
| Obese (≥30.00) | 114 | 39.9 | |
| Children (2 – 12 years) | | | |
| Weight (kg) | | | 25.4±12.0 |
| Height (cm) | | | 119.3±22.0 |
| Weight-for-age (WAZ)[†] | 235 | | -0.15±1.67 |
| Underweight (< -2.0 SD) | 29 | 12.3 | |
| Normal (-2.0 – 2.0 SD) | 179 | 76.2 | |
| Overweight (> 2.0 SD) | 27 | 11.5 | |
| Height-for-age (HAZ) | 286 | | -0.44±1.86 |
| Stunting (<-2.0 SD) | 48 | 16.8 | |
| Normal (-2.0 – 2.0 SD) | 238 | 83.2 | |
| BMI-for-age (BAZ) | 286 | | 0.10±2.09 |
| Wasted (<-2.0 SD) | 47 | 16.4 | |
| Normal (-2.0 – 1.0 SD) | 153 | 53.5 | |
| Overweight (>1.0 SD)[‡] | 37 | 12.9 | |
| Obese (>2.0 SD)[‡] | 49 | 17.1 | |
| Household DBM status | | | |
| BMI mother - WAZ child | 235 | | |
| DBM (mOver/cUnder) | 22 | 9.4 | |
| Non-DBM | 213 | 90.6 | |
| BMI mother - HAZ child | 286 | | |
| DBM (mOver/cStunt) | 37 | 12.9 | |
| Non-DBM | 249 | 87.1 | |
| BMI mother - BAZ child | 286 | | |
| DBM (mOver/cWasted) | 34 | 11.9 | |
| Non-DBM | 252 | 88.1 | |
| Overall DBM[§] | 72 | 25.2 | |
| Overall Non-DBM | 214 | 74.8 | |

DBM: Double burden of malnutrition; mOver/cUnder: Overweight/obese mother with underweight child; mOver/cStunt: Overweight/obese mother with stunted child; mOver/cWasted: Overweight/obese mother with wasted child

[†]Weight-for-age (WAZ) only for children aged 2-10 years, *n*=235;

[‡]Overweight (BAZ >2.0 SD) and obese (BAZ >3.0 SD) for children below five years

[§]Household with overweight/obese mother with undernourished child (underweight/stunting/wasting)

**Table 5.** Multiple binary logistic regression of associated factors with double burden of malnutrition (*N*=286)

| *Predictors* | *AOR* | *95% CI* | |
|---|---|---|---|
| | | *Lower bound* | *Upper bound* |
| Age of mother (years) | | | |
| 20 – 29 | 3.118* | 1.079 | 9.007 |
| 30 – 39 | 2.402 | 0.967 | 5.969 |
| 40 – 49 | Ref (1.000) | | |
| Household size | | | |
| ≤4 | Ref (1.000) | | |
| >4 | 2.391* | 1.102 | 5.187 |
| Household income per capita (MYR) | 1.002* | 1.000 | 1.003 |
| Monthly non-food expenses (MYR) | 0.999* | 0.998 | 1.000 |
| Child's M-HEI score for fish and seafood intake | 0.892* | 0.812 | 0.980 |

MYR: Malaysian Ringgit; M-HEI: Malaysian Healthy Eating Index; *AOR:* Adjusted odds ratio; *CI:* Confidence interval; Ref: Reference
Binary dependent outcome = DBM and Non-DBM
*$p$<0.05

**Factors associated with double burden of malnutrition households**

The multiple binary logistic regression analysis indicated that younger mothers [*AOR*=3.118, 95% *CI* (1.079, 9.007), $p$=0.036], larger household size [*AOR*=2.391, 95% *CI* (1.102, 5.187), $p$=0.027], and higher household income per capita (relative to study population) [*AOR* =1.002, 95% *CI* (1.000, 1.003), $p$=0.029] were significantly associated with higher DBM occurrence. Conversely, higher monthly non-food expenses [*AOR*=0.999, 95% *CI* (0.998, 1.000), $p$=0.012] and greater fish and seafood HEI scores among children [*AOR*=0.892, 95% *CI* (0.812, 0.980), $p$=0.017) were significantly associated with lower DBM occurrence (Table 5).

## DISCUSSION

DBM occurrence has been reported in other indigenous communities, including in Guatemala and Brazil (Coimbra *et al.*, 2021; Ramirez-Zea *et al.*, 2014). Among the indigenous communities in Peninsular Malaysia, Saibul *et al.* (2009) showed that 25.8% of DBM households comprised of overweight or obese mothers with an underweight child aged 2 – 9 years, whereas Wong *et al.* (2015) reported 12.5% of DBM households with children aged under five. In the present study, DBM prevalence was evident among indigenous households in Sarawak, but at a lower rate (9.4%). This outcome could be attributed to the lower proportions of underweight children compared to earlier studies. The prevalence of overweight or obese mothers with a stunted child (12.9%) was lower compared to Wong *et al.* (2015) (19.4%). In this study, the mean height of mothers was 153.0 cm, slightly taller than mothers within the *Orang Asli* community (148.7 cm) (Wong *et al.*, 2015). Shorter mothers (<150.0 cm) have been significantly linked to households with an overweight or obese mother and a stunted child (Oddo *et al.*, 2012), which could explain the lower prevalence of overweight or obese mothers with a stunted child in the present study.

The overall prevalence of underweight/stunted/wasted children

with overweight or obese mother pairings (25.2%) was higher in the present study than the 20.0% reported by Wong *et al.* (2015). The inclusion of underweight and stunted children paired with overweight or obese mothers in the earlier study could explain this outcome. In addition, the proportion of overweight and obese mothers in this study was considerably high, consistent with earlier studies involving indigenous populations (Ramirez-Zea *et al.*, 2014; Saibul *et al.*, 2009). This might also be attributed to the Movement Control Order (MCO) during data collection, in which mothers and children had minimal physical activities. Interestingly, the proportion of overweight and obesity among children in the current study was considerably higher, with a prevalence of 30.0%; while the proportions of underweight, stunting, and wasting in this study were not as alarming compared to the indigenous children in Peninsular Malaysia (Wong *et al.*, 2015). Undernutrition among the indigenous children in Sarawak remains a critical issue that should be addressed.

Earlier studies have demonstrated that older mothers were at higher risk of DBM, contradicting the current study findings. In this study, younger mothers (20 – 29 years) were three times more likely to experience DBM compared to their older counterparts. Falster *et al.* (2018) reported a higher risk of developmental vulnerability among children born to younger mothers, particularly those with a lower socioeconomic status. Conversely, mothers in their late twenties to mid-thirties were less susceptible to DBM. Developmental vulnerabilities reportedly reduce with maternal age (15–49 years), particularly among non-indigenous children compared to their indigenous counterparts (Hanly *et al.*, 2020). Young mothers are still developing biologically, which includes their physical and emotional growth. Thus, their bodies might not be fully prepared for pregnancy and childbirth, potentially affecting the child's development. Additionally, younger mothers may lack the knowledge and experience essential for optimal child growth. A study performed in Nepal revealed that older mothers (≥35 years at pregnancy) were 2.5 times more likely to provide their children with food that meets the minimum dietary diversity than young mothers (15–19 years) during pregnancy (Khanal, Sauer & Zhao, 2013). Although the current study did not examine infant and young child feeding (IYCF) practices, the association between younger mothers and DBM suggests their lack of knowledge and experience in proper child feeding.

The current study also found that larger household size was associated with DBM, which is consistent with earlier studies. A study in rural Indonesia showed that households with more family members were more vulnerable to DBM (Oddo *et al.*, 2012). Notably, household size is a crucial determinant of food insecurity, suggesting the link between DBM and food security (Gubert *et al.*, 2017). In a larger family, food sources become limited due to food insecurity, poor accessibility, and lack of food availability. Distributing food equally between family members is challenging when food supply is scarce. Another study by Wibowo *et al.* (2015) highlighted the association between intra-household food distribution and DBM, characterised by lower calorie, carbohydrate, protein, and fat intakes in children and greater carbohydrate intake in mothers than other family members.

This study observed several large households that practiced joint-family living, where multiple generations reside in the same house. Economically productive household members, traditionally the men, are favoured regarding food allocation as they are perceived to require more energy to

be the primary income provider. This situation potentially leads to inadequate nutrient intake among children, as they are perceived to require smaller food portions than adults. Moreover, Wibowo *et al.* (2015) found that mothers consumed more macronutrients, mainly carbohydrates, than other household members. This finding could be the underlying cause for the higher risk of overweight or obesity among mothers and homemakers in that study. However, this does not apply to the current study, as lower than recommended carbohydrate intake among mothers may be due to underreporting.

Higher monthly household income per capita indicates better overall socioeconomic status within a household, which implies that residents have greater access to processed and ultra-processed foods instead of obtaining food via traditional methods. The present study revealed a significant but weak association between higher household income per capita and DBM, consistent with Oddo *et al.* (2012), who reported almost twice as much DBM occurrence in Bangladesh households with higher socioeconomic status. In contrast, Nakphong & Beltrán-Sánchez (2021) reported that overweight mothers in the poorest household quintiles had at least 2.5 times the risk of having a stunted child than the richest quintiles between the years 2000–2005 and 2010–2014. These discrepancies may be attributed to the inclusion of reported assets and household characteristics to determine household wealth quintiles in earlier studies, while the present study only examined household income per capita. The Malaysian nutrient uptake is transitioning towards that of a Western diet, characterised by high energy intake but a poor nutritional profile. Likewise, Rodrigues *et al.* (2023) suggested that the lifestyle of the Brazilian indigenous population has also changed, reflected in the high prevalence of metabolic syndrome. Therefore, a dietary intake lacking in essential nutrients could be the primary factor that contributes to overweight and obesity among mothers and undernutrition in children (Popkin *et al.*, 2020), particularly within the indigenous population. Notably, excessive fat intake in mothers and children was observed in this study. High fat consumption in children may reduce intake of essential nutrients, potentially contributing to stunting and exacerbating undernutrition by displacing proteins, vitamins, and minerals crucial for growth and development.

Household expenses are another socioeconomic status indicator highlighting the link between household income and expenditure. Contrary to initial findings regarding higher socioeconomic status as a predictor of DBM, stable socioeconomic status is a protective mechanism against DBM. The household income per capita and monthly non-food expenditure showed weak associations with DBM, suggesting a complex relationship between these variables. This current study reported a lower likelihood of DBM occurrence in households with higher monthly non-food expenses. According to Engel's law, the proportion of income spent on food decreases as income increases, as households dedicate a greater share of their income to non-food expenses to improve their general livelihood (Zhu *et al.*, 2022). This outcome indicates that these households have greater access to nutritious food and healthcare, thus improving the overall nutritional status of adults and children. Furthermore, households that spend more on non-food items imply better food security as their accessibility and availability of food supply are not restricted by financial constraints, leading to sufficient food intake and adequate nutrients that

fulfil their dietary needs. Nonetheless, higher non-food expenditure may not always reflect better nutrition, as a mother's knowledge and children's food preferences could influence DBM status in a household.

In households where children consumed more fish and seafood in this study, the likelihood of DBM occurrence was reduced. Good sources of complete protein include meat, poultry, fish, and eggs (NCCFN, 2017). Despite the favourable dietary score for meat, poultry, and eggs observed among children in this study, their fish and seafood intake was poor, as indicated by the low M-HEI score. Limited access and availability to fish and seafood poses a challenge for households to incorporate these foods into their diets. Other factors, such as the monsoon season, can affect fish landings and fluctuations in catch rates in Sarawak's coastal areas. Extreme weather conditions (storms and turbulent waves) also influence fish and seafood intake in the local households. These conditions limit fishing activities, reduce fish supply, and increase prices of goods in the local market (Mustafa *et al.*, 2021), forcing households with financial constraints to opt for more affordable food choices as an alternative to fish and seafood. As a result, children from DBM households might have low fish and seafood intake due to limited accessibility and availability of these essential food sources.

### Strengths and limitations

The current study was one of the first research reports on DBM occurrence at the household level and its associated factors among the indigenous communities in Sarawak. The 24-hour dietary recall offered detailed insights into daily food intake, but its accuracy can be compromised by reliance on participants' memory, leading to potential recall bias and underreporting. Nevertheless, the study was limited by the DBM definition adopted in this study, which emphasised less on the notable prevalence of overweight and obesity among the Sarawak indigenous children. It is recommended that future studies investigate the triple burden of malnutrition, which includes assessing mothers with overnutrition, children with concurrent stunting, and those who are overweight or obese.

## CONCLUSION

This study highlighted a notable prevalence of DBM at 25.2% among indigenous households in Sarawak. Younger mothers, larger household sizes, and higher household income per capita were identified as significant factors associated with DBM occurrence. On the contrary, households with higher monthly non-food expenditures and higher fish and seafood intake among children were less likely to experience DBM. These findings revealed the complex interplay between household socioeconomic characteristics and dietary factors, which led to DBM occurrence within the indigenous population. Future research is recommended to emphasise socioeconomic factors and dietary patterns that potentially influence DBM prevalence among the Sarawakian indigenous communities.

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**Authors' contributions**

Yolanda S, conceptualised and designed the study, conducted the study, data analysis and interpretation, prepared the draft of the

manuscript, and reviewed the manuscript; Cheah WL, conceptualised the study, advised on data collection, analysis and interpretation, and reviewed the manuscript; Law LS, conceptualised the study, advised on data collection, analysis and interpretation, and reviewed the manuscript; Jeffery S, advised on conceptualisation and study design, and reviewed the manuscript; Teoh WJ, conducted data collection, data analysis and interpretation, reviewed the manuscript.

**Conflict of interest**

The authors declare no conflict of interest.

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