



ASSESSMENT OF DIETARY INTAKE IN CHILDREN AGED 1 TO 3 YEARS IN TERENGGANU

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Abstract

This study aimed to determine the average dietary intake and BMI status of children, as well as their association. A total of 161 children aged 2.58 years (SD = 0.70) were involved (75 boys [46.6%], 86 girls [53.4%]). Parents recorded dietary intake using a 3-day food record. Height and weight were measured using a SECA scale and stadiometer, and BMI was analyzed via WHO Anthro software. Mean energy intake was 1113.33 kcal/day (SD = 213.35). Mean intakes for protein, carbohydrate, and fat (% energy) were 16.09 (SD = 2.04), 49.46 (SD = 5.35), and 31.35 (SD = 14.74), respectively. All participants (100%) met protein recommendations, but only 46% and 59% met carbohydrate and fat recommendations. Calcium and vitamin D intakes were insufficient. Most children (88.8%) had a normal BMI z-score. Only carbohydrate, fiber, total fat, and saturated fat intakes correlated significantly ($p < 0.05$) with BMI status. In conclusion, energy, protein, and fat intakes were adequate, whereas carbohydrate, calcium, and vitamin D intakes were deficient. Although most children had a normal BMI, high energy intake and dietary composition (carbohydrate, fiber, and fats) require careful monitoring as they influence changes in BMI status.

Keywords: Mean dietary intake, BMI, children, food records.

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INTRODUCTION

Global estimates highlight that malnutrition encompassing stunting, wasting, and obesity remains a major early childhood health threat (UNICEF, 2020; WHO, 2021). Malnutrition in children aged 1 to 3 years significantly escalates the risks of illness and mortality risks (Prendergast & Humphrey, 2014). Early dietary habits lay the groundwork for lifelong nutritional patterns and metabolic health (Birch et al., 2014; Verduci et al., 2019). Globally, dietary imbalances persist; while nutrient-dense foods like iron-rich cereals are frequently consumed, fruit, vegetable and fiber intakes remain inadequate, alongside excessive consumption of energy-dense foods (Au et al., 2018; Gubbels et al., 2014).

Furthermore, early childhood dietary patterns are increasingly skewed toward energy-dense, nutrient-poor foods, establishing dietary behaviors that persist into later childhood and elevate the risk

of overweight and obesity (Rose et al., 2017; Gubbels et al., 2013). Studies across European cohorts consistently report excessive intakes of saturated fats, sodium and unhealthy processed foods alongside deficits in essential fatty acids, fiber, fruits and vegetables (Gubbels et al., 2013; Madrigal et al., 2020; Steenbergen et al., 2021). In Malaysia, a parallel trend is observed where young children fail to meet national guidelines; over a third fall short of energy, calcium, and vitamin D requirements while fruit and vegetable intakes remains severely inadequate with only around 12% to 16% meeting daily recommendations (Poh et al., 2013; Chong et al., 2017; Salleh et al., 2021). These widespread dietary imbalances highlight the critical need for early interventions to promote adherence to age-appropriate dietary recommendations.

In Malaysia, national data reveal a pressing double burden of malnutrition among under-fives: 14.1% are underweight, 21.8% are stunted, 9.7% are wasted, and 5.6% are overweight or obese (NHMS, 2019). Notably, rural populations and B40 low-income households bear the highest burden of stunting (22.4%) and underweight (15.6%), while Malay children exhibit the highest prevalence of wasting (11.7%) (NHMS, 2019). Socioeconomic status (SES), parental education and parental perceptions heavily influence dietary adequacy and feeding practices (Galgamuwa et al., 2017).

Although portion sizes are standardized via the Malaysian Dietary Guidelines for Children and Adolescents (NCCFN, 2023) and Recommended Nutrient Intakes (RNI, 2017), practical application remains problematic. Standard guidelines rely on household measurements that vary regionally, making them difficult to interpret for rural or low-literacy caregivers (Zainal Badari et al., 2015). Furthermore, estimating portion sizes in low-resource settings is challenging due to the lack of standardized models for local foods (FAO). Consequently, parents often struggle to quantify age-appropriate portions, frequently relying on adult meal portions as a benchmark (Curtis et al., 2017). Although caregivers can adjust portions when clear guidance is available (Reale et al., 2019; BDA, 2021), context-specific data remain critical.

Despite the high prevalence of childhood malnutrition in rural and B40 populations, empirical data regarding children's dietary intake, and its association with BMI status in Terengganu remains strikingly scarce. Existing Malaysian dietary guidelines have limited data on portion sizes for children aged 1 to 3 years, leaving a clear research gap in understanding whether actual dietary intake aligns with RNI (2017) recommendations within this specific population.

This cross-sectional study addresses this empirical gap by evaluating mean dietary intake adequacy against RNI (2017) guidelines, parental portion size perceptions, and its associations with BMI status among children aged 1 to 3 years in Terengganu (specifically across Yayasan Pembangunan Keluarga Terengganu [YPKT] centers). This study provides critical localized evidence to inform age-appropriate dietary guidance, empower caregivers, and ultimately mitigate childhood under- and over-nutrition.

OBJECTIVES

1. To determine the association between mean dietary intake and BMI status among children aged from 1 to 3 years in TASKA YPKT Kuala Nerus and Kuala Terengganu.
2. To evaluate the mean dietary intake among children aged 1 to 3 years in TASKA YPKT Kuala Nerus and Kuala Terengganu.
3. To identify the BMI status among children aged from 1 to 3 years in TASKA YPKT Kuala Nerus and Kuala Terengganu.

METHODOLOGY

Study Design

The study was approved by the UniSZA Human Research Ethics Committee (UHREC). This study used a cross-sectional design involving mothers of children aged 1 to 3 years from all districts in Terengganu. A cross-sectional study design was selected for the population-based survey as it is usually low-cost and provides a faster method of collecting information and data from participants. This study was conducted both online and face-to-face; therefore, participants were required to access a link to complete the survey online. After mothers of children aged 1 to 3 years whose children attended Yayasan Pembangunan Keluarga Terengganu (YPKT) centres agreed to participate in the study and signed a consent form, the mothers were asked to complete a questionnaire. The questionnaire included items on children's dietary intake, anthropometric data, and sociodemographic characteristics such as the ages of both mothers and children, ethnicity and level of education. In this study, mean dietary intake served as the primary independent variable while BMI status represented the main dependent variable.

Respondents and sampling

Study participants comprised mothers of healthy children aged 1 to 3 years attending TASKA PERMATA Keluarga under Yayasan Pembangunan Keluarga Terengganu (YPKT) across all districts in Terengganu. Participants were selected using a stratified random sampling method with strata defined by district. Inclusion criteria required participants to be mothers of healthy, non-medicated children residing in Terengganu and to be literate in English or Bahasa Melayu. Mothers were excluded if their children had chronic diseases, neurological disorders, physical disabilities or were receiving continuous medical treatment.

The required sample size was calculated using the two-proportion formula to examine associations between dietary intake and BMI status. Data from a previous study was used to estimate the minimum number of children required in the study; assuming a proportion of the outcome in the exposed group of 0.61, a proportion of the outcome in the unexposed group of 0.76 (Foo et al., 2020), and a significance level of $p=0.05$, and a power of 80%. This calculation indicated that 146 children were needed. After accounting for an anticipated 20% drop-out rate, the target sample size was adjusted to 183 respondents. A total of 183 responses were obtained; however, after data cleaning, 22 responses were excluded due to incomplete, missing, or unusable data, resulting in a final sample of 161 respondents for analysis. The comprehensive step-by-step calculation is presented in Figure 1.

$$\begin{aligned}n &= (1.96+0.84)^2 * (0.76 (1-0.76) + 0.61 (1-0.61) / (0.61-0.76)^2 \\n &= 146 \text{ mothers with their children dropped out } 20\%, \\n &= 146 / (1-0.2) \\&= 183 \text{ mothers with their children}\end{aligned}$$

Figure 1 : Sample size calculation

Measures

Sociodemographic characteristics

These characteristics were measured: Children's and parents' age, gender, childcare center, ethnic groups (Malay, Chinese, Indian or others), marital status (married, separated/divorce, single or mother/father), highest education level of father and mother (no schooling, primary school, secondary school, diploma/ form 6 or tertiary education) , monthly income (<RM4,851, RM4,851 – RM10,970 or >RM10,970) and district in Terengganu (Kuala Nerus or Kuala Terengganu).

Dietary Intake

Children's dietary intake was assessed using an estimated food record over a non-consecutive 7-day period (2 weekdays and 1 weekend). Dietary intake data were collected for meals consumed at the childcare centre, at home after returning from the childcare centre and during the weekend. Caregivers at the childcare centres recorded the foods and beverages consumed by the children while at the centre and subsequently passed the food records to the parents for completion of the remaining dietary intake.

Along with the food record template, examples and pictures of food portion sizes and common household measures were provided to assist mothers in estimating serving sizes. The pictures of food portion sizes and household measures were based on the e Food Atlas: Size Portion and Exchange (Suzana et al. 2015). The food record template included columns for time, place, mealtime (breakfast, morning tea, lunch, afternoon tea, dinner, supper and snacks), food and beverages consumed, including product brand and type, quantity consumed and cooking method. Dietary intake data were analysed using Nutritionist Pro software and compared with the Malaysian Recommended Nutrient Intakes (RNI) (NCCFN, 2017).

Anthropometry Measurement

The BMI status of the children was assessed using anthropometric measurements of height (cm) and weight (kg). Weight was measured using a weighing scale, while height was measured using a stadiometer. The researchers visited the childcare centres to conduct the measurements. BMI was calculated as body weight (kg)/ height (m²). BMI-for-age was interpreted according to the WHO Child Growth Standards for children aged 0 to 5 years. The WHO Multicentre Growth Reference Study (MGRS) was implemented to provide data for the construction of growth curves from birth to 5 years of age (Wijnhoven et al., 2004). The operational definitions for BMI status were explicitly detailed

based on the WHO Child Growth Standards (2006) using WHO Anthro software, and were defined as Underweight (< -2 SD), Normal (-2 to $+2$ SD), Overweight ($> +2$ SD), and Obese ($> +3$ SD).

Data Analysis

Data were analyzed using IBM SPSS Statistics Version 26.0, with WHO Anthro (Version 1.0.4) used to compute age- and gender-specific BMI-for-age Z-scores. Data normality was assessed via the Kolmogorov-Smirnov test. Continuous variables were expressed as means $\pm$ standard deviations for normally distributed data, or median and interquartile range (IQR) for skewed data, while categorical variables are reported as frequencies and percentages. To determine the association between dietary intake, and children's BMI, simple linear regression was first performed to screen individual potential predictors, followed by multivariable linear regression to adjust for confounders. For all regression models, the continuous BMI-for-age Z-score was designated as the dependent outcome and results were expressed using regression coefficients (β), 95% confidence intervals (CI), and coefficients of determination (R^2). Statistical significance was set at $p < 0.05$.

RESULTS

Sociodemographic Characteristics of Respondents

A total of 161 children, with a mean age of 2.58 years (SD=0.70), participated in this study. Among the participants, 26 (16.1%) were 1 year old, 73 (45.3%) were 2 years old, and 62 (38.5%) were 3 years old. The gender distribution revealed that 75 (46.6%) were boys and 86 (53.4%) were girls, with all participants of Malay ethnicity.

Table 1.1 displays the sociodemographic characteristics of the study population. The mean age of the parents was 34.47 years (SD=4.58), with the majority aged 31 to 40 years (70.7%). Most parents were married (97%), while 2 (1.5%) were divorced, and 2 (1.5%) were single parents. Regarding household income, the majority (76.7%) of parents reported low income ($<$ RM 4,851). Geographically, 55.3% of the children were from Kuala Nerus, while 44.7% were from Kuala Terengganu.

Table 1.1 Sociodemographic characteristics of study population.

Parameters	Mean (SD)	n (%)
Children age (years) (n=161)	2.58 (0.70)	
1		26 (16.1)
2		73 (45.3)
3		62 (38.5)
Gender (n=161)		
Boys		75 (46.6)
Girls		86 (53.4)

Ethnicity (n=161)	
Malay	161 (100)
Parent's age (n=133)	
	34.47 (4.58)
20-30	25 (18.8)
31-40	94 (70.7)
40-50	14 (10.5)
Parent's marital status (n=133)	
Married	129 (97)
Divorced parent	2 (1.50)
Single parent	2 (1.50)
Income (n=133)	
< 4,851	102 (76.7)
4851-10,970	31 (23.3)
Region (161)	
Kuala Nerus	89 (55.3)
Kuala Terengganu	72 (44.7)

Mean Dietary Intake

An analysis of the mean dietary intake of children in YPKT Kuala Nerus and Kuala Terengganu, along with the number and percentage of children meeting the Malaysian Recommended Nutrient Intake (RNI) 2017 is presented in Table 1.2. Mean dietary intakes were analysed by gender and for the overall study population. The mean energy intake for all children was 1113.33 kcal/day (SD= 213.35). This amount exceeded the recommended energy intake for children which is 980 kcal/d and 900 kcal/day for boys and girls, respectively. Mean intake for protein, carbohydrate and fat (% energy) was 16.09 (SD= 2.04), 49.46 (SD= 5.35) and 34.70 (SD= 4.40) from total energy intake respectively.

All children met the recommendation for protein intake as a percentage of total daily energy intake. However, only 46% (n=74) and 59% (n=95) met the recommendation intakes for carbohydrate and fat respectively. For total fat intake, (% energy), 41% (n=66) exceeded the recommended percentage of total daily energy intake. Nevertheless, the intake of saturated fatty acid (SFA) was favourable, as 96.9% (n= 156) met the recommendation of less than 10% SFA from total daily energy intake, with a mean intake of 6.33% of total energy. About one-third of the children (35.4%) met the RNI 2017 guidelines regarding fibre intake. Similarly, children's daily sugar intake was in line with recommendations where the mean intake was 5.64% of total energy intake and 95% (n=153) met the

recommendation. The mean calcium intake among children was 515.42 mg/day (SD = 181.43), which was below the recommended calcium intake of 700 mg/d. Meanwhile, the mean Vitamin D intake among children was 1.30 µg/day (SD = 3.45), which was below the recommended intake of 15 µg/d.

Table 1.2 Mean dietary intake of children in YPKT Kuala Nerus and Kuala Terengganu

Dietary Intake	Boy (N= 75)	Girls (N= 86)	Total (N= 161)		Percentage of Children Meeting the Guideline* (%) (Frequency)
	Mean (SD)	Mean (SD)	Mean (SD)	Median (25th centile)	
Energy (kcal/d)	1100.42 (216.02)	1124.59 (211.61)	1113.33 (213.35)		33.54 (54)
Protein (%en)	15.86 (1.87)	16.28 (2.18)	16.09 (2.04)		100.00 (161)
Carbohydrate (%en)	50.43 (5.13)	48.61 (5.41)	49.46 (5.35)		46.00 (74)
Fibre (g/d)	28.61 (13.8)	33.75 (15.19)	31.35 (14.74)		35.40 (57)
Sugar (%en)	6.36 (10.27)	5.02 (6.92)	5.64 (8.64)	3.50 (2.67)	95.00 (153)
Total fat (%en)	33.89 (4.22)	35.39 (4.46)	34.70 (4.40)	41.80 (35.39)	59.00 (95)
Saturated fat (%en)	5.93 (1.46)	6.67 (2.01)	6.33 (1.81)	7.56 (5.9)	96.90 (156)
Fe (mg/d)	9.8703 (4.26)	8.93 (4.27)	9.37 (4.27)	8.42 (6.80)	87.0 (140)
Ca (mg/d)	487.14 (169.93)	540.08 (188.42)	515.42 (181.43)		18.00 (29)
Vitamin C (mg/d)	54.89 (91.83)	49.05 (49.45)	51.77 (72.17)		50.3 (81)

Vitamin D (µg/d)	1.40 (4.27)	1.2049 (2.54)	1.30 (3.45)	1.3 (2)
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*Recommended Nutrient Intake (RNI) 2017

Daily Dietary Intake of Children Based on Serving Size of Different Food Groups

Table 1.3 shows the daily dietary intake of children based on serving size of different food groups. The median intake for fat and sugar were 1.50 servings/day (IQR= 1.00-2.50) and 0.75 servings/day (IQR= 0.00-1.50), respectively. In addition, the median intake of dairy products was 0.25 servings/day (IQR= 0.00-0.50). This value was lower than the reference value of 2 servings of dairy product per day, however the maximum intake among the study population was 2.50 serving/day. The mean intake of meat, poultry and legumes was 1.16 servings/day (SD= 0.46) which was within the recommended range of 1–2 servings/day. Nevertheless, the overall intakes of vegetables and fruits were below the recommended daily serving sizes for both food groups. The mean intake of vegetables was 0.37 servings/day (SD= 0.29) while median intake of fruits was 0.50 servings/day (IQR= 0.50-1.00). For cereals, bread, rice, and pasta, the mean intake was 4.00 servings/day (SD = 1.09), which was within the recommended range of 3–5 servings/day.

Table 1.3 Daily dietary intake of children based on serving size of different food groups

Food Groups	Dietary intake (serving/day), (n=159)			Reference value*
	Mean (SD)	Median (25th-75th centile)	Min-Max	
Fat	1.97 (1.22)	1.50 (1.00-2.50)	0.00-8.00	-
Sugar	1.18 (1.44)	0.75 (0.00-1.50)	0.00-6.50	-
Dairy Products	0.37 (0.45)	0.25 (0.00-0.50)	0.00-2.50	2
Meat, poultry & legumes	1.16 (0.46)		0.50-2.50	1-2
Vegetables	0.37 (0.29)		0.00-1.50	2-3
Fruits	0.70 (0.64)	0.50 (0.50-1.00)	0.00-5.00	2
Cereals, bread, rice and pasta	4.00 (1.09)		2.00-8.50	3-5

* Malaysian Food Pyramid 2020

Anthropometric Data

The study population had a mean weight and height of 12.29 kg (SD= 2.13) and 89.14 cm (SD= 7.08), respectively. In this study, the majority of children had a normal BMI status, (88.8%). A total of 3.1% (n= 5) were severely underweight, 7.5% (n= 7) were underweight and 3.7% (n= 6) were overweight. Overall, the majority of children in YPKT Kuala Nerus and Kuala Terengganu had a normal BMI and no children with obesity were reported in this study. Table 1.4 displays the anthropometric data of the children.

Table 1.4 Anthropometric data of children.

Variables	Frequency	Percentage	Mean (SD)
Weight (kg)			12.29 (2.13)
Height (cm)			89.14 (7.08)
BMI-for-age (BAZ)			
Severely underweight	5	3.1	
Underweight	7	7.5	
Normal	143	88.8	
Overweight	6	3.7	

BMI Status by Age

Table 1.5 shows the BMI status of children by age. Based on the data, 2 years old children had the highest frequency of normal BMI status, n= 65 (40.4%) but also had the highest prevalence of underweight, at 2.5% (n= 4). Overall, the number of children who were underweight or overweight was similar across all age groups.

Table 1.5 BMI status of children by their age

Age (Years)	BMI-for-age, z-scores n (%)			
	Severely underweight	Underweight	Normal	Overweight
1	0 (0)	3 (1.9)	20 (12.4)	3 (1.9)
2	4 (2.50)	2 (1.2)	65 (40.4)	2 (1.2)
3	1 (0.6)	2 (1.2)	58 (40.6)	1 (0.6)

BMI status by gender

Descriptive analyses of the BMI status of children by gender are shown in Table 1.6. Among the children, 1.2% of boys and 1.9% of girls were severely underweight, while 2.5% of boys and 1.9% of girls were underweight. Girls had higher prevalence of normal BMI-for-age with 47.8% (n=77) than boys with 41.0% (n=66). The prevalence of overweight was the same for boys and girls, with each accounting for 1.9% of the study population.

Table 1.6 BMI status of children across gender

Gender	BMI-for-age, z-scores n (%)			
	Severely underweight	Underweight	Normal	Overweight
Boys	2 (1.2)	4 (2.5)	66 (41.0)	3 (1.9)
Girls	3 (1.9)	3 (1.9)	77 (47.8)	3 (1.9)

Association between Mean Dietary Intake and BMI Status Among Children

Table 1.7 presents the association between mean dietary intake and BMI status among children in both YPKT in Terengganu. Of all of the dietary variables examined (energy, protein, carbohydrate, fibre, sugar, total fat, saturated fat, sodium, iron, calcium, vitamin C and vitamin D), only carbohydrate, fibre, total fat and saturated fat showed significant associations with BMI status ($p < 0.05$).

This study showed a significant negative association between the percentage of energy intake from carbohydrate and BMI status, $\beta = -0.036$ (CI= -0.070, -0.003), $p = 0.033$. This shows that, for every one percent increase in carbohydrate, BMI decreased by 0.036 kg/m². There was also a significant association between the percentage intake of fat with BMI status, $\beta = 0.041$ (CI= 0.000, 0.082), $p = 0.049$. It indicates that for every one percent increase in fat intake, BMI increased by 0.041 kg/m².

The percentage of saturated fat taken daily showed a positive association between the percentage intake of saturated fatty-acid with BMI status, $\beta = 0.143$ (CI= 0.046, 0.241), $p = 0.004$. Thus, for every one percent increase in saturated fatty-acid intake, BMI increased by 0.143 kg/m². Lastly, fiber intake showed a negative association with BMI status, $\beta = -0.013$ (CI= -0.025, 0.000), $p = 0.043$. For every one gram increase in total dietary fiber intake, BMI decreased by 0.013 kg/m².

Table 1.7 Association between mean dietary intake and BMI status among children.

Dietary Intake	BMI-for-age (BAZ)	
	β (95% CI)	p value
Energy (kcal/d)	0.001(0.000, 0.001)	0.245

Protein (%en)	0.035(-0.054, 0.123)	0.443
Carbohydrate (%en)	-0.036(-0.07, -0.003)	0.033*
Fibre (g/d)	-0.013(-0.025, 0.000)	0.043*
Sugar (g/d)	0.011(-0.010, 0.032)	0.313
Total fat (%en)	0.041(0.000, 0.082)	0.049*
Saturated fat (%en)	0.143(0.046, 0.241)	0.004*
Fe (mg/d)	0.011(-0.031, 0.054)	0.594
Ca (mg/d)	0.000(-0.001, 0.001)	0.635
Vitamin C (mg/d)	-0.002(-0.004, 0.001)	0.193
Vitamin D (µg/d)	-0.017(-0.070, 0.036)	0.524

* p value significant at $p < 0.05$

DISCUSSION

The daily energy intake among children aged 1 to 3 years in this study was relatively high compared with current dietary guidelines, with girls exceeding the recommended intake by 25% and boys exceeding their recommended intake by 12%. This finding aligns with observations among Dutch children, where over half of the study population surpassed energy recommendations (Gubbels et al., 2014). However, the finding that girls had a higher mean energy intake than boys contrasts with the Nutrition Survey of Malaysian Children (SEANUTS Malaysia), which reported greater energy consumption among boys (Poh et al., 2013). This divergence suggests that local household feeding practices and early exposure to energy-dense family meals in Terengganu may contribute to differences from broader national gender-based intake trends (Muniandy et al., 2020; Salleh et al., 2021).

In terms of macronutrient distribution, all children met the recommended protein intake, with a mean intake exceeding 15% of total energy intake (TEI). Although protein is essential for cellular growth, excessive protein intake during early childhood has been associated with an increased risk of childhood obesity (Verduci et al., 2019; Pimpin et al., 2016). Conversely, more than half of the study population failed to meet the recommended proportion of energy from carbohydrates (<45–60% TEI),

diverging from typical pediatric dietary patterns (Verduci et al., 2019). This lower carbohydrate intake was accompanied by relatively high total fat consumption, consistent with findings among children aged two to six years in Pulau Tuba, Langkawi (Salleh et al., 2021).

This high-energy and high-fat intake pattern aligns with broader dietary trends observed among children across Southeast Asia. Regional evidence, such as findings from the South East Asian Nutrition Surveys (SEANUTS), highlights that pediatric populations in countries like Malaysia and Thailand frequently exhibit sub-optimal dietary behaviors, including high protein intake and frequent snacking or fast-food consumption. For instance, Chong et al. (2016) reported that a notable proportion of Malaysian children indulge in frequent snacking and weekly fast-food intake, which contribute to high caloric density and irregular meal patterns. Similarly, findings by Rojroongwasinkul et al. (2013) in Thailand demonstrate elevated protein and energy intakes alongside persistent micronutrient deficiencies. This broader multi-country landscape evaluated across Southeast Asia, including Malaysia, Indonesia, Thailand, and Vietnam (Tan et al., 2024) underscores a common dietary transition where energy-dense intake often overrides overall nutrient quality, thereby predisposing children to potential long-term metabolic imbalances.

More than one-third of the children (35.4%) met the recommendation of 20 to 30 g/day for total dietary fibre. This finding differs from two previous studies, which reported low or insufficient dietary fibre intake among younger toddlers aged 1–3 years (Gubbels et al., 2014) and children aged 1–6 years (Chong et al., 2017). The favourable sugar intake observed in this study may partly reflect dietary patterns that included fibre-rich foods (Finn et al., 2019); however, the cross-sectional design does not allow a direct relationship between fibre and sugar intake to be established. Furthermore, adequate fibre and Vitamin C intakes (mean 51.77 mg/day) facilitated dietary iron absorption (Collings et al., 2013; Finn et al., 2019), resulting in adequate iron status across the cohort. On the other hand, calcium and Vitamin D intakes were severely deficient, with only 18% meeting calcium guidelines and only two children meeting Vitamin D requirements. The low calcium intake may partly reflect the low consumption of dairy products observed in this study.

Regarding weight status, the majority of children had a normal BMI z-score (88.8%). The prevalence of overweight was low at 3.7%, considerably lower than international figures reported by Shi et al. (2018) (31.6%) but comparable to findings by Galgamuwa et al. (2017) (5.8%). While national statistics from the NHMS 2019 show higher overall malnutrition rates due to broader sociodemographic sampling, the presence of children with underweight and overweight in this sample underscores the need for continued nutritional monitoring at the childcare level.

Statistical analysis revealed significant associations between BMI status and intakes of carbohydrates, total fat, saturated fatty acids (SFA), and dietary fibre. Consuming carbohydrates within recommended proportions (47% to 64% TEI) has been associated with a lower risk of obesity (Gaesser, 2007; Merchant et al., 2009). Conversely, excessive fat intake may promote a positive energy balance that contributes to body weight gain and increased obesity risk (Millar et al., 2014; Wang et al., 2020). Specifically, every 1% increase in SFA intake was associated with a 0.143 kg/m² increase in BMI. Nevertheless, the majority of children had a normal BMI while the average SFA intake remained within the recommended level. Additionally, dietary fibre showed a significant negative association with BMI, consistent with previous evidence suggesting a potential protective role of fibre-rich dietary patterns against excessive weight gain (Kranz et al., 2012; Buscemi et al., 2018; Fayet-Moore et al., 2016).

Although protein intake did not show a statistically significant association with BMI status in the present study, broader literature highlights that elevated early protein consumption promotes weight gain and elevates later childhood obesity risk (Pimpin et al., 2016; Steenbergen et al., 2021). These findings collectively suggest that optimizing macronutrient distribution particularly by moderating protein and saturated fat intake while maintaining adequate dietary fibre during early childhood is essential for supporting healthy growth trajectories and preventing early-onset obesity (Pimpin et al., 2016; Steenbergen et al., 2021).

Furthermore, these findings carry practical implications for childcare centers (TASKA), parents, and early childhood educators. Childcare centres represent important environments for shaping children's dietary habits. TASKA menus could undergo regular nutritional evaluation to ensure that meals are appropriately balanced in energy and nutrients, particularly saturated fat, calcium, and vitamin D. Educators and caregivers may also benefit from training in portion control and meal planning to ensure that foods served align with age-appropriate nutritional guidelines. Regarding parents and primary caregivers, nutrition education could provide practical guidance on appropriate portion sizes, nutrition label reading, and the identification of saturated fats and added sugars in commercial foods. Parents should also be encouraged to provide a variety of nutrient-dense foods, particularly dairy products, fruits, vegetables and other appropriate whole foods. Finally, greater coordination of feeding practices between home and TASKA environments may help promote consistent healthy eating practices. Routine anthropometric and dietary monitoring at TASKA centres may facilitate the early identification of unfavourable changes in growth or dietary intake, allowing timely nutritional guidance.

CONCLUSION

In conclusion, this cross-sectional study showed that energy, protein and fat intakes among children aged 1 to 3 years in YPKT Kuala Nerus and Kuala Terengganu were adequate to excessive while carbohydrate intake was below the recommended intake. Although the majority of children had a normal BMI-for-age Z-score, elevated total fat intake was observed alongside critical deficiencies in calcium and vitamin D. Furthermore, significant cross-sectional associations were identified between BMI status and the intake of carbohydrates, total fat, saturated fat, and dietary fibre. Given the observational design these findings highlight potential dietary imbalances that warrant attention without implying direct causality.

Regarding methodological strengths and limitations, the study benefited from standardized anthropometric measurement procedures using standardised equipment and the provision of visual portion-estimation guides to minimize dietary reporting bias. However, due to the cross-sectional design, temporal or causal relationships between dietary variables and BMI status cannot be established. Additionally, the findings are limited by the relatively small and geographically restricted sample, as well as potential self-reporting inaccuracies inherent in caregiver-recorded food records. The intensive 3-day food recording process may have contributed to incomplete dietary data, further limiting the generalizability of the findings to the broader population. Moving forward, future studies employing longitudinal or prospective cohort designs with larger, ethnically diverse samples are recommended to better elucidate potential causal pathways across Malaysia. Incorporating additional anthropometric indicators (such as waist circumference, skinfold thickness and head circumference)

alongside detailed classifications of specific macronutrient sources and dietary supplement use would yield deeper insights. Finally, comparative evaluations of dietary patterns between home and childcare environments could inform targeted menu interventions to support early childhood nutrition.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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AUTHOR CONTRIBUTIONS STATEMENT

Nurul Bahirah Mohd Shariff : Conceptualization, methodology, formal analysis, visualization and writing.

Nurfariana Diana Mohd Nor : Supervision, validation, writing review and editing, resources.

Che Suhaili Che Taha: Supervision, writing review and editing, resources.

Nur Atirah Hassan Basri: Data curation, investigation, writing review and editing.

AVAILABILITY OF DATA AND MATERIALS

The data supporting this study's findings are available on request from the corresponding author.

ETHICS STATEMENT

The study was approved by the UniSZA Human Research Ethics Committee (UHREC). Written informed consent was obtained from all participants prior to the commencement of the study.

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