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Maternal nutrition knowledge, infant feeding practices, and linear growth of 6-12 months old infants in Kuala Lumpur and Putrajaya

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ABSTRACT

Introduction: Stunting is a serious form of childhood undernutrition due to its long-term impact on growth and development. This study aimed to determine the associations between maternal nutrition knowledge, infant feeding practices, and linear growth of infants aged 6-12 months in Kuala Lumpur and Putrajaya. **Methods:** This cross-sectional study was conducted on 229 mothers with infants aged 6-12 months. Socio-demographic background, anthropometric measurements, infant feeding practices, and maternal nutrition knowledge were assessed through questionnaires. Length-for-age z-score (LAZ) was calculated using WHO Anthro software and classified based on WHO child growth standards. Infant and Young Child Feeding Index (ICFI) was used to measure infant feeding practices. **Results:** Mean total percentage score of maternal nutrition knowledge was 77.90% (*SD*=7.99), while mean ICFI total score was 6.73 (*SD*=1.40). Mean LAZ was -0.62 (*SD*=1.08) and stunting prevalence was 10.9%. Total ICFI score (r=0.162, p=0.014), infant's age (r=-0.146, p=0.028), maternal height (r=0.310, p<0.001), and birth weight (r=0.370, p<0.001) were significantly associated with LAZ in the bivariate analysis. There was no significant association between maternal nutrition knowledge and linear growth (p>0.05). Multivariate analysis indicated that birth weight (B=0.850, p<0.001), maternal height (B=0.045, p<0.001), infant's age (B=-0.076, p=0.009), infant's sex (B=-0.253, p<0.047), and total ICFI score (B=0.094, p=0.048) were significant contributors of infants' linear growth. **Conclusion:** Infant feeding practices were associated with linear growth of infants, but not maternal nutrition knowledge. Therefore, the ability to put knowledge into practices is deemed important.

Keywords: Maternal nutrition knowledge, infant feeding practices, linear growth, stunting

INTRODUCTION

Linear growth in early childhood is recognised as a strong indicator of healthy growth as it is associated with morbidity and mortality risks, learning capacity, productivity, and non-communicable disease risk in later life (WHO, 2015). Linear growth is generally expressed as length/height-for-age z-score (L/HAZ); children are defined as stunted if their L/HAZ is less than two standard deviations (SD) of the Child Growth Standards median (WHO, 2015). Linear growth retardation or stunting is a

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serious form of childhood undernutrition as it inflicts irreversible harm to child growth and development (WHO, 2015). Studies reported that stunting often occurs during the complementary feeding period, between 6 to 24 months of age, due to rapid growth and increased exposure to infectious diseases (Oyda *et al.,* 2017).

As the main care provider, mothers play an essential role in determining the nutritional status of their children. Studies showed that higher maternal nutrition knowledge is associated with higher LAZ in children under 5 years old (Marbun *et al.,* 2022). Mothers who are equipped with good nutrition knowledge are expected to apply their knowledge in feeding their children with adequate nutrition to support optimal growth (Marbun *et al.,* 2022). Without sufficient knowledge, malnutrition can occur even in households with sufficient food and income, good sanitation, and health services (Jemide *et al.,* 2016). Maternal nutrition knowledge is an important factor that could influence feeding practices, hence the linear growth of infants.

Infant and young child feeding (IYCF) practices exert a direct effect on the growth and development of children below two years of age (WHO & UNICEF, 2021). Cumulative evidence supported that infant feeding practices, as measured by the Infant and Young Child Feeding Index (ICFI), are significantly associated with the linear growth of infants (Reinbott *et al.,* 2015; Oyda *et al.,* 2017; Chaudhary *et al.,* 2018). ICFI combines several key dimensions of feeding practices into a composite index, thus it could reflect the possible combined impact on the nutritional status of children (Oyda *et al.,* 2017). A previous study revealed that ICFI would be a better tool to evaluate feeding practices in relation to linear growth compared to single WHO IYCF indicators such as minimum dietary diversity (MDD), minimum meal frequency (MMF), and minimum acceptable diet (MAD) (Reinbott *et al.,* 2015). Inappropriate complementary feeding practices, such as early introduction of complementary feeding, insufficient feeding frequency, and low dietary diversity, could increase the risk of linear growth retardation (WHO & UNICEF 2021). Hence, assessing infant feeding practices could provide insight regarding their contributions to the linear growth of infants.

According to the National Health and Morbidity Survey (NHMS) 2019, the national prevalence of stunting below five years of age increased from 16.6% in 2011 to 21.8% in 2019 (IPH, 2019). The stunting prevalence in Putrajaya is 24.3%, surpassing the national stunting prevalence, while Kuala Lumpur's stunting prevalence is also concerning, recorded at 10.5%, despite these two states being the highest-income states in Malaysia (IPH, 2016). Furthermore, a study conducted in Kuala Lumpur and Putrajaya found that only 68.8% of breastfed infants and 34.6% of non-breastfed infants met the criteria of MAD (Khor *et al.,* 2016). Meanwhile, data on the association between maternal nutrition knowledge and linear growth of infants in Malaysia are scarce. Children with impaired linear growth tend to have poor physical growth, decreased cognitive function, poor educational performance, lack of productivity, higher risk of developing chronic diseases, and low adult wages in later life (WHO, 2015). Hence, it is imperative to tackle this issue at an early stage. Evidence showed that poor maternal nutrition knowledge and inappropriate infant feeding practices are significantly linked to poor linear growth of infants (Jemide *et al.,* 2016). Therefore, the present study aimed to determine the associations between maternal nutrition knowledge, infant feeding practices, and linear growth

of infants aged 6-12 months in Kuala Lumpur and Putrajaya.

MATERIALS AND METHODS

Study design and subjects

This was a cross-sectional study conducted from November 2022 to February 2023 at four selected government Maternal and Child Health (MCH) clinics. A list of government health clinics that provided MCH services in Kuala Lumpur and Putrajaya was obtained from the MyHealth portal website. Among 27 MCH clinics in Kuala Lumpur and Putrajaya, four clinics were selected through convenience sampling, including Klinik Komuniti Kuchai Entrepreneurs Park, Klinik Kesihatan Putrajaya Presint 9, Klinik Kesihatan Putrajaya Presint 11, and Klinik Kesihatan Putrajaya Presint 18. Sample size was calculated by following the formula for correlation as the response variable (Cole, 2006), $n = [(Z_{1-\alpha/2}+Z_{1-\beta/2})^2/(r^2/(1-r^2))]+5$ (n=sample size, α=probability of making Type I error, β=probability of making Type II error), whereby $Z_{1-\alpha/2}$=1.96, $Z_{1-\beta/2}$= 0.84, and r=0.202 (Reinbott *et al.,* 2015). Considering a dropout rate of 20%, the total sample size required was 228.

Mothers with infants aged 6-12 months old who fulfilled the inclusion criteria were randomly recruited when they visited the selected MCH clinics for periodic check-ups. The inclusion criteria were: (i) mothers with infants aged 6-12 months; (ii) singleton pregnancy; and (iii) at term infants (≥37 weeks gestation). Mothers below 18 years old or infants with physical or congenital abnormalities were excluded from this study. Informed consent was obtained from mothers before data collection. Ethical approval was obtained from the Medical Research and Ethics Committee [NMRR no.: ID-22-00182-HIP (IIR)]. Permission to collect data at the selected clinics was obtained from the Kuala Lumpur and Putrajaya Federal Territory Health Departments prior to data collection.

Research instruments

Both physical and online questionnaires (Google Form) were used in the present study, with most of the data collected using physical questionnaires through face-to-face interviews. The face-to-face interviews were conducted while mothers were waiting for their periodical check-ups at the clinic. On the other hand, a small number of mothers self-administered the online questionnaire using their smartphones by scanning the QR code provided. The researcher remained with the participants throughout the completion of the online questionnaire, providing guidance as needed whenever participants had questions.

The survey questionnaires were bilingual (Malay and English) and consisted of four parts (Parts A, B, C, and D). Part A consisted of questions regarding socio-demographic background, which included ethnicity (Malay, Chinese, Indian, Others – including other Bumiputera and non-Malaysian), education level (no formal education, primary, secondary, and tertiary education), mother's age, employment status (employed and unemployed), monthly household income, infant's gestational age, sex, and date of birth.

Part B included anthropometric measurements of mothers (height) and infants (birth weight and current length). Maternal height was self-reported and maternal short stature was defined as maternal height <150cm (WHO, 2007). Infant's birth weight was obtained from the child's health record book (*Buku Rekod Kesihatan Bayi*), while the current recumbent length was measured to the nearest 0.1 cm using SECA infantometer (SECA 416). The current length was

converted to LAZ by utilising the WHO Anthro software version 3.2.2 and infants were categorised as stunted if LAZ <-2*SD*, based on the WHO Child Growth Standards (WHO, 2006). Additionally, low birth weight was defined as birth weight <2.5kg (WHO, 2006).

Part C was related to maternal nutrition knowledge. The questionnaire was adapted from the knowledge domain of the Infant and Young Child Feeding Questionnaire for Child Care Providers (IYCF-CCPQ) by Zakria, Wan & Sulaiman (2019). IYCF-CCPQ is a validated questionnaire developed by Malaysian researchers to assess knowledge, attitudes, and practices regarding IYCF among child caregivers. The knowledge domain of the IYCF-CCPQ consisted of two sections with a total of 99 items. The first section assessed knowledge on breastfeeding and infant formula feeding (64 items); the second section assessed knowledge on complementary feeding (35 items). Each correct answer was given a score of 1 and 0 for a wrong answer. Total percentage score was calculated with the formula: (total score/99) x 100%.

Part D assessed infant feeding practices using the ICFI (Ruel & Menon, 2002; Wondafrash *et al.,* 2017). ICFI was developed by combining IYCF indicators into a single index and consisted of five components, including breastfeeding, bottle-feeding, dietary diversity, food group frequency, and meal frequency. The breastfeeding component was analysed by asking mothers "What type of milk is your child drinking now?", whereas the bottle-feeding component was assessed by using a binary question (yes or no), which was "Did you give your child any drink by using a baby bottle?". Dietary diversity and food group frequency components were measured based on the seven food groups consumed by an infant in the past 24 hours and past seven days, respectively. The seven defined food groups were: (1) grains/tubers, (2) dairy products, (3) meat/fish/poultry, (4) eggs, (5) legumes, (6) vitamin A-rich fruits and vegetables, and (7) other fruits/vegetables. Additionally, the meal frequency component was gauged according to the frequency of meals (excluding breast milk) consumed by the infant in the past 24 hours. The scoring procedures for ICFI differed by age group, thus its score was calculated by age groups 6-8 months and 9-12 months. For each component, a positive feeding practice was given a score of either 1 or 2 and a negative feeding practice was given a score of 0. The total score was calculated by summing up the score for each component; the possible total score ranged from 0-9. Details of the scoring system are shown in Table 1.

Data analysis

Data analysis was conducted using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). Internal consistency for the maternal nutrition knowledge questionnaire was assessed using Cronbach's alpha coefficient. All univariate analysis was performed using descriptive statistics. Pearson's correlation was conducted to determine the associations between monthly household income, birth weight, maternal height, maternal nutrition knowledge, infant feeding practices (total ICFI score), and linear growth (LAZ) of infants. Chi-square tests were performed to determine the associations between sex, maternal education level, and LAZ status of infants. Multiple linear regression was carried out using the stepwise method to determine factors that contributed to the linear growth of infants. All variables were examined for the assumptions of linearity, normality, multicollinearity, and homoscedasticity of residuals. Level of statistical significance was set at $p<0.05$. After removing incomplete questionnaires and outliers (LAZ <–6*SD* or >+6*SD*), the final

Table 1. Scoring system for Infant and Young Child Feeding Index (ICFI) by age group

ICFI Component	*Age group*	
	6 - 8 months	*9 - 12 months*
Breastfeeding	No = 0 Yes = 2	No = 0 Yes = 2
Bottle-feeding	No= 1 Yes = 0	No = 1 Yes = 0
Dietary diversity (past 24 hours)[†]	0 - 1 food group = 0 2 food groups = 1 3+ food groups = 2	0 - 2 food groups = 0 3 food groups = 1 4+ food groups = 2
Food group frequency (past 7 days)[†,‡]	0 - 2 = 0 3 - 4 = 1 5+ = 2	0 - 3 = 0 4 - 5 = 1 6+ = 2
Meal frequency (past 24 hours)[§]	0 meals = 0 1 meal = 1 2+ meals = 2	0 meals = 0 1 - 2 meals = 1 3+ meals = 2
Total score	9	9

[†]Dietary diversity and food group frequency consisted of 7 food groups: (1) grains/tubers, (2) dairy products, (3) meat/fish/poultry, (4) eggs, (5) legumes, (6) vitamin A-rich fruits and vegetables, and (7) other fruits/vegetables.
[‡]Each food group scored 0 points if not consumed within the past 7 days, scored 1 point if consumed on 1-3 days, and scored 2 points if consumed on at least 4 days or more.
[§]Meal frequency only refers to solid, semi-solid or soft foods consumed in the past 24 hours and does not include breast milk or any other liquids.

sample size included in the analysis was 229.

RESULTS

Socio-demographic backgrounds and characteristics

A total of 229 mother-infant pairs were recruited from the four selected clinics, which were Klinik Komuniti Kuchai Entrepreneurs Park (*n*=86), Klinik Kesihatan Putrajaya Presint 9 (*n*=46), Klinik Kesihatan Putrajaya Presint 11 (*n*=8), and Klinik Kesihatan Putrajaya Presint 18 (*n*=89). Socio-demographic backgrounds and characteristics of mothers and infants in this study are presented in Table 2. Mean age of mothers was 32.98±4.92 years old. Most of the mothers were Malays (79.9%), attained tertiary education (76.4%), working (73.8%), and had a normal height (≥150 cm) (91.7%). Mean household income was RM6318.02±242.14, with the majority belonging to the M40 income group (60.2%). Mean age for the 299 infants was 9.31±2.23 months, with 31.0% aged 6-8 months and 69.0% aged 9-12 months. The percentage of male (46.7%) and female (53.3%) infants was about the same. All infants enrolled in this study were born at term (≥37 gestational weeks) and the majority of them (93.4%) had a normal birth weight (≥2.5kg).

Maternal nutrition knowledge

Mean total percentage score for maternal nutrition knowledge was 77.90% (*SD*=7.99). Mothers scored 77.12±9.28% for Section A (knowledge of breastfeeding and infant formula) and 79.34±8.90% for Section B (knowledge of complementary feeding) (Table 2).

Infant feeding practices

The distribution of ICFI components by age group is outlined in Table 3. More than half (63.3%) of the mothers

Table 2. Socio-demographic background, characteristics of the mothers and infants, and maternal nutrition knowledge *(N*=229*)*

Variables	*n (%)*	*Mean±SD*
Maternal characteristics		
Age (years)		32.98±4.92
21 to 30	83 (36.2)	
31 to 40	134 (58.5)	
41 to 45	12 (5.3)	
Ethnicity		
Malay	183 (79.9)	
Chinese	34 (14.8)	
Indian	5 (2.2)	
Others	7 (3.1)	
Monthly household income (RM)		6318.02±242.14
B40 (≤ RM4,850)	76 (33.2)	
M40 (RM4,851 - RM 10,970)	138 (60.2)	
T20 (>RM 10, 970)	15 (6.6)	
Education level		
Secondary education	54 (23.6)	
Tertiary education	175 (76.4)	
Employment status		
Working	169 (73.8)	
Not working	60 (26.2)	
Maternal height (cm)		157.43±6.04
Short stature (<150 cm)	19 (8.3)	
Normal stature (≥150 cm)	210 (91.7)	
Infant characteristics		
Age (months)		9.31±2.23
6 - 8	71 (31.0)	
9 - 12	158 (69.0)	
Sex		
Male	107 (46.7)	
Female	122 (53.3)	
Gestational age (weeks)		38.37±1.15
37 - 39	180 (78.6)	
40 - 42	49 (21.4)	
Length-for-age z-score (LAZ)		-0.62±1.08
Stunted (< -2SD)	25 (10.9)	
Non-stunted (≥-2 SD)	204 (89.1)	
Birth weight (kg)		3.06±0.41
Low birth weight (<2.5 kg)	15 (6.6)	
Normal birth weight (≥2.5 kg)	214 (93.4)	
Maternal nutrition knowledge percentage score (%)		
Breastfeeding and infant formula		77.12±9.28
Complementary feeding		79.34±8.90
Total score		77.90±7.99

B40: Bottom 40% household income; M40: middle 40% household income; T20: Top 20% household income

Table 3. Distribution of Infant and Young Child Feeding Index (ICFI) components by age group, *n* (%)

ICFI component	*6 - 8 months (n=71)*	*9 - 12 months (n=158)*	*All (N=229)*
Breastfeeding			
Yes	46 (64.8)	99 (62.7)	145 (63.3)
No	25 (35.2)	59 (37.3)	84 (36.7)
Bottle-feeding			
Yes	58 (81.7)	138 (87.3)	196 (85.6)
No	13 (18.3)	20 (12.7)	33 (14.4)
Dietary diversity†			
Low	6 (8.5)	11 (7.0)	17 (7.4)
Medium	19 (26.8)	16 (10.1)	35 (15.3)
High	46 (64.8)	131 (82.9)	177 (77.3)
Food group frequency†			
Low	4 (5.6)	1 (0.6)	5 (2.2)
Medium	18 (25.4)	1 (0.6)	19 (8.3)
High	49 (69.0)	156 (98.7)	205 (89.5)
Meal Frequency†			
Low	1 (1.4)	0 (0.0)	1 (0.4)
Medium	19 (26.8)	34 (21.5)	53 (23.1)
High	51 (71.8)	124 (78.5)	175 (76.4)
Total ICFI score (mean±*SD*)	6.35±1.57	6.91±1.27	6.73±1.40

†The low, medium, and high categories were classified according to the points assigned for the ICFI components as described in Table 1, where 0 = low, +1 = medium, and +2 = high

continued to breastfeed their infants beyond six months of age, while 36.7% of the mothers did not breastfeed their infants. Out of those who breastfed their infants, 29.3% practised mixed feeding. The overall percentage of bottle-feeding (use of a bottle with a nipple to consume any food or drink, including breast milk) was 85.6%. Most of the infants had a high dietary diversity score (77.3%), high food group frequency score (89.5%), and high meal frequency score (76.4%). Overall, the mean total ICFI score of all infants was 6.73±1.40 out of a maximum possible score of 9.

Linear growth of infants

Mean LAZ was -0.62 (*SD*=1.08) and the prevalence of stunting among the infants was 10.9% (Table 2). Malays (12.0%) and the M40 income group (13.0%) had the highest proportion of stunting. The prevalence of stunting was higher among infants with working mothers (11.8%) than those who were housewives (8.3%). Among the two age groups, infants aged 9 to 12 months reported a higher percentage of stunting (12.7%) than infants aged 6 to 8 months (7.0%). In terms of sex, the prevalence of stunting was higher among males (13.1%) than females (9.0%). The prevalence of stunting was also higher among infants with low birth weight (33.3%) than infants with normal birth weight (9.3%), as well as among those of mothers with short stature (21.1%) than those of mothers with normal stature (10.0%).

Table 4. Associations between sociodemographic background and characteristics with LAZ of infants (*N*=229)

Variable	*Stunted*	*LAZ*		
	n (%)	χ^2	*r*	*p*
Maternal education level		0.200		0.655
Secondary	5 (20.0)			
Tertiary	20 (80.0)			
Infant's sex		0.970		0.325
Male	14 (56.0)			
Female	11 (44.0)			
Total ICFI score			0.162	0.014*
Monthly household income			0.008	0.904
Infant's age			-0.146	0.028*
Birth weight			0.370	<0.001**
Maternal height			0.310	<0.001**
Maternal nutrition knowledge percentage score			0.038	0.564

LAZ: Length-for-age z-score; ICFI: Infant and Young Child Feeding Index
*p<0.05; **p<0.001

Factors associated with linear growth of infants

Table 4 shows the bivariate analysis of socio-demographic background, characteristics of the mothers and infants, maternal nutrition knowledge, and feeding practices with LAZ of the infants. Maternal height (r=0.310, p<0.001), infant's birth weight (r=0.370, p<0.001), and total ICFI score (r=0.162, p=0.014) were found to be positively associated with LAZ of infants, while infants' age was negatively associated with LAZ (r=-0.146, p=0.028). On the other hand, there were no significant associations between maternal nutrition knowledge, monthly household income, sex, and maternal education level with LAZ of infants (p>0.05).

Results of the multivariate analysis on factors associated with the linear growth of infants are shown in Table 5. Infant's birth weight (B=0.850, p<0.001), maternal height (B=0.045, p<0.001), infant's age (B=-0.076, p=0.009), sex (B=-0.253, p=0.047), and total ICFI score (B=0.094, p=0.048) were found to be significantly associated with the linear growth of infants. Birth weight was found to be the strongest predictor for the linear growth of infants and explained about 13.7% of the variances in linear growth. Maternal height, infant's age, and sex contributed to 6.8%, 1.7%, and 1.5%, respectively, of the variances in the linear growth of infants. Infant feeding practices, as indicated by total ICFI score, explained about 1.3% of the variances in the linear growth of infants. Collectively, 25.0% of the variances in LAZ can be explained by the predictors listed in Table 5.

DISCUSSION

The mean percentage scores of maternal nutrition knowledge on breastfeeding and infant formula and complementary feeding were 77.12% and 79.34%, respectively, while the mean total percentage score was 77.90%. The maternal nutrition knowledge scores obtained in the present study were higher than a previous study conducted in Kelantan (Zakria *et al.,* 2019), where they found that the mean percentage

Table 5. Multivariate analysis of factors contributing to linear growth of infants (*N*=229)

Variables	*B*	*β*	*t*	*p*	*R*	R^2	ΔR^2
Constant	-10.050		-5.959				
Birth weight	0.850	0.323	5.352	<0.001**	0.370	0.137	0.137
Maternal height	0.045	0.250	4.252	<0.001**	0.453	0.205	0.068
Infant's age	-0.076	-0.158	-2.628	0.009*	0.470	0.221	0.017
Sex	-0.253	-0.117	-2.002	0.047*	0.486	0.237	0.015
Total ICFI score†	0.094	0.122	1.989	0.048*	0.500	0.250	0.013

B: Unstandardised coefficients; *β*: Standardised coefficients; ICFI: Infant and Young Child Feeding Index

*p<0.05; **p<0.001; F =14.853, p<0.001

†The association between ICFI and LAZ was adjusted for socio-demographic background (infant's age, sex, maternal education level, and monthly household income), infant's birth weight, maternal height, and maternal nutrition knowledge.

score for knowledge on breastfeeding and infant formula was 67.19%, while complementary feeding was 68.72%. The results of maternal nutrition knowledge revealed that most mothers (73.8%) had a misassumption that infant formula was nutritious because it consisted of added docosahexaenoic acid (DHA). In addition, more than half of the mothers were not aware of the appropriate timing for introducing allergenic foods such as eggs (88.2%) and prawns (68.1%). Besides, only 26.4% of mothers were aware of the correct number of levels in the food pyramid. Hence, these findings shed light on the urgent need for tailored nutrition education interventions focusing on advocating the nutritional advantages of breast milk compared to formula, the right proportion of food groups for complementary feeding, and the appropriate timing of introducing allergenic foods to improve feeding practices and subsequently reduce the risk of stunting. Studies proved that effective nutrition education interventions could significantly improve mothers' knowledge and feeding practices (Dangura & Gebremedhin 2017).

In terms of infant feeding practices, the mean total ICFI score of all infants was 6.73, which was higher than previous studies conducted in Bangladesh (Khatoon *et al.,* 2011) and India (Lohia & Udipi, 2014), where the mean ICFI scores were 6.4 and 5.9, respectively. However, there was a high prevalence of non-compliance observed with WHO's recommended IYCF indicators, particularly the bottle-feeding indicator. Bottle-feeding is considered a harmful practice mainly due to hygiene concerns as baby bottles are difficult to keep clean, thereby increasing the risk of pathogen transmission (WHO & UNICEF, 2021). The percentage of bottle-feeding (85.6%) obtained was also higher compared to a previous study conducted in Kuala Lumpur and Putrajaya (80.4%) (Khor *et al.,* 2016). Besides, only 63.3% continued breastfeeding, 77.3% achieved high dietary diversity, and 76.4% met the criteria of high meal frequency. The findings indicated that there is a necessity for better monitoring of feeding practices during postnatal care.

The present study found that mean LAZ was -0.62 and the stunting prevalence was 10.9%. The prevalence of stunting in this study was lower than the national prevalence and a previous study in Malaysia. The NMHS 2019 showed that the national stunting prevalence among children aged below five years was 21.8% (IPH, 2019), while the UNICEF Children Without Report

found that the stunting prevalence among children below 5 years old living in low-cost housing in Kuala Lumpur was 22% (UNICEF, 2018). The lower stunting prevalence obtained might be attributed to the small sample size. In addition, more than half of the mothers involved in the present study belonged to the M40 population (60.2%) and attained tertiary education (76.4%). Participants with higher socioeconomic status can afford essential needs for their children, including medical care, nutritious food, and improved sanitation. Mothers with higher education level also tend to have better health awareness and utilise health facilities to meet their children's nutritional requirements (Wulandari *et al.,* 2022). Since data collection took place at clinics, this indicated that all infants involved in the present study had access to health services. Hence, future studies should recruit a larger sample size to ensure the representativeness of the population, including infants who do not attend periodic medical check-ups, particularly those from lower socioeconomic households.

Results from multivariate analysis revealed that birth weight was the most prominent predictor for linear growth of infants. The finding is in line with previous studies conducted in Negeri Sembilan (Murtaza *et al.,* 2018) and Sarawak (Gahamat, Rahman & Siddiq, 2022). Low birth weight is found to be caused by intrauterine growth restriction (IUGR) or prematurity (WHO, 2023). It is also recognised as an indicator of chronic maternal malnutrition and poor health care in pregnancy (WHO, 2023). Evidence also found that low birth weight infants tend to have IUGR despite being born at term (Utami *et al.,* 2018). The findings of this study supported the importance of birth weight in influencing infants' linear growth. Hence, the results emphasised the significance of having optimal maternal nutrition before and during pregnancy to ensure a healthy pregnancy outcome, which can subsequently improve the linear growth of infants.

This study also showed that maternal height was significantly correlated with the linear growth of infants. This finding is consistent with previous studies, which found that infants born to short mothers were more likely to have poor linear growth (Murtaza *et al.,* 2018; Khatun *et al.,* 2019). Maternal short stature is a sign of chronic cumulative nutritional deficiency over long periods (Khatun *et al.,* 2019). Mothers with short stature tend to deliver stunted children (Utami *et al.,* 2018). Studies supported that short mothers are more likely to have restricted uterine blood flow and a narrower pelvis, which in turn result in a sub-optimum uterine environment for foetal growth, consequently impairing the linear growth of infants in later life (Utami *et al.,* 2018; Khatun *et al.,* 2019). Therefore, the finding supported the intergenerational transmission of stunting from mothers to their children, which also indicated the importance of detecting linear growth retardation at an early stage to break the intergenerational cycle of stunting.

Moreover, infants' age was negatively associated with LAZ. Previous studies also reported similar findings, whereby the stunting risk among older children was higher in comparison with younger children (Khatoon *et al.,* 2011; Chaudhary *et al.,* 2018). A study revealed that the possible reason stunting prevalence increases with age might be due to the cumulation of inappropriate feeding practices (Khatoon *et al.,* 2011). Chaudhary *et al.* (2018) also reported that this could be due to more care being provided to younger children and older children being more likely to get infections, which may result in poorer linear growth. Thus, this finding suggested that an age-specific

intervention or monitoring should be conducted as infant feeding practices change rapidly within short age intervals.

The results showed that there was a positive and significant association between total ICFI score and LAZ of infants, indicating better feeding practices were associated with improved linear growth of infants. This finding is similar to previous studies by Khatoon *et al.* (2011), Lohia & Udipi (2014), Oyda *et al.* (2017), and Chaudhary *et al.* (2018). Therefore, these findings reinforced the evidence that optimal feeding practices play an essential role in improving the linear growth of infants. A previous study found that mothers who received education about IYCF during postnatal care were significantly associated with higher dietary diversity (Dangura & Gebremedhin, 2017). Hence, education interventions can be implemented to educate mothers or caregivers regarding appropriate feeding practices, which in turn help lower the risk of stunting. Additionally, the results reaffirmed the potential of the ICFI in explaining the relationship between IYCF practices and infants' linear growth, as combining several IYCF indicators into a single composite index could better reflect the collective effects of suboptimal feeding practices (Oyda *et al.,* 2017).

Besides, the finding indicated that males were significantly associated with lower LAZ as compared to females. This finding coincides with a nationwide survey of 15,331 Malaysian children below five years of age, wherein boys were significantly more susceptible to stunting than girls (Lee *et al.,* 2022). A recent study involving 152 children under the age of five in Sarawak also revealed that males (*AOR*=1.931) were significantly correlated with stunting (Gahamat *et al.,* 2022). Another meta-analysis also revealed that boys were more susceptible to stunting, wasting or being underweight than females (Thurstans *et al.,* 2020). Thurstans *et al.* (2020) also stated that there was no satisfactory evidence currently explaining the sex differences in the context of stunting, thus future research is needed to further identify potential reasons for these differences, as well as their implications for nutrition policy and practice.

Contrary to expectation, there was no significant association between maternal nutrition knowledge and the linear growth of infants even after covariate adjustment. The finding is not aligned with a previous study, which found that higher maternal nutrition knowledge was significantly correlated with better linear growth (Marbun *et al.*, 2022). However, it is in line with a study conducted in Terengganu, which found no significant association between mothers' feeding knowledge and LAZ among children aged 2 to 4 years (Zakaria *et al.,* 2022). The possible explanation for this finding is that mothers did not apply their nutrition knowledge in feeding their infants, thereby good maternal nutrition knowledge did not contribute to improving linear growth. This assumption was supported by a previous study, which demonstrated that although most mothers were equipped with good complementary feeding knowledge, the feeding practices remained suboptimal, as many working mothers perceived that a high workload reduced the time available for providing optimal feeding to their children (Rakotomanana *et al.,* 2020). In addition, a study done in Selangor discovered that the lack of a supportive environment and facilities were factors associated with the cessation of breastfeeding among working mothers (Rashid *et al.,* 2018). Furthermore, most of the mothers (73.8%) in this study were working mothers, thus they might not be the primary caregivers of their children due to time constraints. The

present study found that good maternal nutrition knowledge does not necessarily translate into optimal feeding practices that could lead to improved linear growth of infants, as other factors or barriers may have a greater influence on infant feeding practices. Therefore, future studies should include primary caregivers in addition to mothers in identifying the barriers that inhibit the translation of nutrition knowledge into optimal infant feeding practices.

There were several shortcomings in the present study. Firstly, maternal height was self-reported, potentially leading to response bias. Additionally, dietary intake relied on retrospective information based on mothers' memory, presenting the possibility of recall bias. Mothers who were not the primary caregivers of their children might also not be fully aware of their infants' daily dietary intake, reducing the accuracy of the dietary data reported. Moreover, this was a cross-sectional study, thus the cause-and-effect relationship between the observed risk factors and infants' linear growth cannot be established. Additionally, this study cannot be generalised to the whole population of infants in Malaysia due to the small sample size and the sampling frame that was limited to four clinics in Kuala Lumpur and Putrajaya only. Additionally, the study only involved infants aged 6 to 12 months old, thus it was not representative of the whole infant population. Since the development of linear growth retardation is a long-term process, future studies should follow-up infants from birth to 2 years of age. Nevertheless, the utilisation of the ICFI to measure infant feeding practices and its association with infants' linear growth provided useful insights into the cumulative effects of inappropriate feeding practices on infants' linear growth. The findings also revealed the suboptimal feeding practices among mothers, providing evidence for developing tailored interventions in future to address particular inappropriate feeding practices.

CONCLUSION

In conclusion, the prevalence of stunting in this study was 10.9%, reflecting that stunting remains a health concern in Malaysia. Infant feeding practices were significantly associated with infants' linear growth, reinforcing their importance in influencing the linear growth of infants, particularly during the first year of life. Nonetheless, maternal nutrition knowledge was not significantly associated with the linear growth of infants, indicating good maternal nutrition knowledge alone is insufficient to improve infants' linear growth. It is important for mothers to be able to put their knowledge into practice. However, factors like work-related time constraints and unsupportive working environments may exert a greater influence on infant feeding practices among working mothers, hindering them from optimal feeding practices. Hence, future research should focus on identifying potential factors that lead to suboptimal feeding practices to ensure infants receive optimal nutrients for optimum growth. Apart from infant feeding practices, birth weight, maternal height, infants' age and sex were significantly associated with the linear growth of infants. Consequently, this study supported the vital role of maternal nutritional status in influencing infants' linear growth. As the adverse consequences of stunting are largely irreversible, preventive measures should be taken from antenatal to postnatal care to prevent infants' growth status from deteriorating further.

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Authors' contributions

Koh SY, conducted data collection, data analysis and interpretation, prepared the draft of the manuscript; Nurliyana AR, conceptualised and designed the study, advised on data analysis and interpretation, and reviewed the manuscript; Satvinder K, co-supervised the study and reviewed the manuscript.

Conflict of interest

The authors declare that they have no conflicts of interest regarding this study.

References

Chaudhary SR, Govil S, Lala MK & Yagnik HB (2018). Infant and Young Child Feeding Index and its association with nutritional status: A cross-sectional study of urban slums of Ahmedabad. *J Family Community Med* 25(2): 88-94.

Cole TJ (2006). Sampling, Study Size, and Power. In BM Margetts & M. Nelson (eds). *Design Concepts in Nutritional Epidemiology* (pp.64-86). Oxford University Press Inc., New York.

Dangura D & Gebremedhin S (2017). Dietary diversity and associated factors among children 6-23 months of age in Gorche district, Southern Ethiopia: Cross-sectional study. *BMC Pediatr* 17(1):6.

Gahamat MF, Rahman MM & Siddiq M (2022). Nutritional status of under-five children and the relationship with household food wastage and food security in Samarahan, Malaysia. *IIUM Med J Malaysia (IMJM)* 21(4):80-88.

IPH (2016). *National Health and Morbidity Survey (NHMS) 2016: Maternal and Child Health (Vol. II).* Institute for Public Health, National Institutes of Health, Ministry of Health, Kuala Lumpur.

IPH (2019). *National Health and Morbidity Survey (NHMS) 2019: Non-Communicable Diseases: Risk Factors and other Health Problems (Vol. I).* Institute for Public Health, National Institutes of Health, Ministry of Health, Kuala Lumpur.

Jemide JO, Ene-Obong HN, Edet EE & Udoh EE (2016). Association of maternal nutrition knowledge and child feeding practices with nutritional status of children in Calabar South Local Government Area, Cross River State, Nigeria. *Int J Home Sci* 2(1):293-298.

Khatoon T, Mollah MA, Choudhury AM, Islam MM & Rahman KM (2011). Association between infant- and child-feeding index and nutritional status: Results from a cross-sectional study among children attending an urban hospital in Bangladesh. *J Health Popul Nutr* 29(4):349-356.

Khatun W, Rasheed S, Alam A, Huda TM & Dibley MJ (2019). Assessing the intergenerational linkage between short maternal stature and under-five stunting and wasting in Bangladesh. *Nutrients* 11(8):1818.

Khor GL, Tan SY, Tan KL, Chan PS & Amarra MS (2016). Compliance with WHO IYCF Indicators and dietary intake adequacy in a sample of Malaysian infants aged 6-23 Months. *Nutrients* 8(12):778.

Lee WS, Jalaludin MY, Khoh KM, Kok JL, Nadarajaw T, Soosai AP, Mukhtar F, Fadzil YJ, Anuar Zaini A, Mohd-Taib SH, Rosly RM, Khoo AJ & Cheang HK (2022). Prevalence of undernutrition and associated factors in young children in Malaysia: A nationwide survey. *Front Pediatr* 10:913850.

Lohia N & Udipi SA (2014). Infant and child feeding index reflects feeding practices, nutritional status of urban slum children. *BMC Pediatr* 14:290.

Marbun RM, Karina SM, Meilinasari M & Mulyo GPE (2022). Correlation of characteristics, maternal nutrition knowledge with nutritional status (H/A) in baduta in Sumbang District, Banyumas Regency, Central Java, Indonesia. *Maced J Med Sci* 10(E):471-474.

Murtaza SF, Gan WY, Sulaiman N & Shariff ZM (2018). Factors associated with stunting among Orang Asli preschool children in Negeri Sembilan, Malaysia. *Mal J Nutr* 24(2):215-226.

Oyda A, Tamiru D, Tesfay A & Mekonnen N (2017). Under nutrition and its association with infant and young child feeding summary index among 6 to 23 months in Demba Gofa Woreda, Southern Ethiopia. *J Nutr Health Food Sci* 5(3):1-15.

Rakotomanana H, Hildebrand D, Gates GE, Thomas DG, Fawbush F & Stoecker BJ (2020). Maternal knowledge, attitudes, and practices of complementary feeding and child undernutrition in the Vakinankaratra region of Madagascar: A mixed methods study. *Curr Dev Nutr* 4(11):nzaa162

Rashid AA, Shamsuddin NH, Ridhuan RDARM, Sallahuddin AN & Devaraj NK (2018). Breastfeeding practice, support, and self-efficacy among working mothers in a rural health clinic in Selangor. *Malays J Med Health Sci* 14(2):39-49.

Reinbott A, Kuchenbecker J, Herrmann J, Jordan I, Muehlhoff E, Kevanna O & Krawinkel M (2015). A child feeding index is superior to WHO IYCF indicators in explaining length-for-age Z-scores of young children in rural Cambodia. *Paediatr Int Child Health* 35(2):124–134.

Ruel MT & Menon P (2002). Child feeding practices are associated with child nutritional status in Latin America: Innovative uses of the demographic and health surveys. *J Nutr* 132:1180–1187.

Thurstans S, Opondo C, Seal A, Wells J, Khara T, Dolam C, Briend A, Myatt M, Garenne M, Sear R & Kerac M (2020). Boys are more likely to be undernourished than girls: A systematic review and meta-analysis of sex differences in undernutrition. *BMJ Glob Health* 5(12):e004030.

UNICEF (2018). *Children Without. A study of urban child poverty and deprivation in low-cost flats in Kuala Lumpur.* United Nations Children's Fund, Putrajaya.

Utami NH, Rachmalina R, Irawati A, Sari K, Rosha BC, Amaliah N & Besral (2018). Short birth length, low birth weight and maternal short stature are dominant risks of stunting among children aged 0-23 months: Evidence from Bogor longitudinal study on child growth and development, Indonesia. *Mal J Nutr* 24(1):11-23.

Wondafrash M, Huybregts L, Lachat C, Bouckaert KP & Kolsteren P (2017). Feeding practices and growth among young children during two seasons in rural Ethiopia. *BMC Nutr* 3:39.

WHO (2006). *WHO Child Growth Standards 2006.* World Health Organization, Geneva.

WHO (2007). *In: Growth reference data for 5-19 years.* From https://www.who.int/tools/growth-reference-data-for-5to19-years. [Retrieved March 10 2023].

WHO (2015). *In: Stunting in a nutshell.* From: https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell [Retrieved March 10 2023].

WHO (2023). *In: Low birth weight.* From https://www.who.int/data/nutrition/nlis/info/low-birth-weight [Retrieved March 10 2023].

WHO & UNICEF (2021). *Indicators for assessing infant and young child feeding practices: definitions and measurement methods.* World Health Organization, Geneva.

Wulandari RD, Laksono AD, Kusrini I & Tahangnacca M (2022). The targets for stunting prevention policies in Papua, Indonesia: What mothers' characteristics matter? *Nutrients* 14(13):549.

Zakaria NS, Asma' A, Zakaria NS, Abd Wahab MR, Lani MN & Meli AM (2022). Association of mothers' child feeding knowledge, attitude, and practices with nutritional status of children under the age of five in a Malaysian fishing community: A cross-sectional study. *Food Res* 6(5):48-55.

Zakria TI, Wan M & Sulaiman (2019). Validation of Infant and Young Child Feeding Questionnaire for the assessment of knowledge, attitudes and practices among child care providers: The IYCF-CCPQ. *Int J Environ Res Public Health* 16(12):2147.