

Research Article

Risk Factors Associated with Underweight Children Under the Age of Five in Putrajaya, Malaysia: A Case-Control Study

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ABSTRACT

The study aimed to determine the associated factors for underweight among children under five years old in Putrajaya, Malaysia. This was a case-control study with a one-to-one ratio matched by sex as well as by three age categories (6–11 months, 12–35 months, dan 36–59 months) between underweight and normal-weight children. There were 364 underweight children and 364 children with normal weight recruited from four government clinics and 118 preschools in Putrajaya. Both groups were assessed via face-to-face interviews; anthropometric measurements; haemoglobin level through finger prick blood sample; and a self-administered 3-day food diary. Underweight is defined as a weight-for-age z score less than -2SD based on World Health Organization (WHO) 2006 Growth Chart. The logistic regression's final model revealed that various factors were significantly associated with underweight among children under five in Putrajaya. These factors included father being employed as a non-government servant [aOR:1.45 (95% CI:1.04–2.02) compared to government servant], children from B40 group with a monthly household income less than <RM 7,380 (USD 1727.33) [aOR:2.17 (95% CI:1.01–4.66) compared to T20], monthly expenditure for childcare less than RM 1,000 (USD 234.06), [aOR:1.77 (95% CI:1.01–3.10) compared to ≥RM 2,000], underweight mother during prepregnancy [aOR:1.89 (95% CI:1.10–3.26)] compared to normal weight, anemic children [aOR:1.57 (95% CI:1.15–2.16)] compared to normal children, children using pacifiers [aOR:1.75 (95% CI:1.21–2.73)] compared to not using pacifiers and children staying with unregistered babysitters [aOR:2.33 (85% CI:1.52–3.59)] compared to those attending kindergarten. The above findings suggest several factors are significantly associated with underweight among children under five years old. Therefore, it highlights on the importance of improving household socioeconomic status, maternal nutritional status, and infant and young child feeding practices to prevent underweight issues in this population.

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INTRODUCTION

Malnutrition comprises undernutrition, micronutrient malnutrition, and obesity

(World Health Organization (WHO) 2017). Undernutrition is the state when an individual lacks an adequate amount of nutrients in his or her body. According to a previous study, around

45% of deaths in children under the age of five are caused by malnutrition, and emerging nations have the highest frequency of early childhood malnutrition based on recent rapidly economic growth (Guyatt *et al.* 2020). Presence of underweight in early childhood may have long-lasting implications. This condition to some extent, interferes with children's physical and cognitive development and reduces their academic performance (Akombi *et al.* 2017). Underweight in children might indicate a nutritional problem that reflects in both wasting and stunting issues (Kurnianingtyas *et al.* 2021). This state of childhood malnutrition could be due to insufficient intake of one or more specific nutrients such as vitamins or minerals (Wells 2019). Nutritional status of women and children are influenced by multiple socioeconomic and cultural factors (Hossain *et al.* 2020; Li *et al.* 2020).

The United Nations (U.N.) approved 17 Sustainable Development Goals (SDGs) in 2015 in order to address the concerns of poverty, inequality, and climate change in the twenty-first century. In favour of improving nutrition, the target is to end malnutrition by 2030 (U.N 2015). The worldwide incidence of underweight among children under the age of five was 15% in 2013 (Mgongo *et al.* 2017). Children with Low Birth Weight (LBW) tend to become underweight later in life if their nutrition intake is not being supervised suitably (UNICEF 2019). Therefore, in Malaysia, an action plan to monitor children under five years old with underweight status was incorporated in the National Plan of action for Nutrition of Malaysia III (2016–2025) (MoHM 2016).

There was 13.7% of children under five years old in Malaysia were underweight (IPH 2016). In comparison, a study of 3,600 children aged 16 years from 14 impoverished communities in Peninsular Malaysia discovered that 32.6% of boys and 35.9% of girls were underweight. Children's nutritional status were affected by different factors such as parental education, feeding practises, maternal nutritional state, the number of under-five children in one household, poverty, access to health facilities, and disparities between urban and rural areas (Motbainor *et al.* 2015). Malnutrition may occur when one receives an inadequate intake of energy and nutrients which are required for normal growth.

The National Health and Morbidity Survey (NHMS) 2016 has shown that Putrajaya

is the fourth state with higher stunting cases after Terengganu, Kelantan, and Pahang (IPH 2016). Despite the fact that the Federal Territory of Putrajaya houses the majority of Malaysia's government officials and has some of the best facilities in the nation, the level of nutritional status of the children residing there was queried. Putrajaya serves as the country's administrative centre. Given this particular reason, and due to lack of data, the study was determined to identify the factors associated with underweight status among children under five years old in Putrajaya.

METHOD

Design, location, and time

The survey was a case-control study over a one-to-one ratio matched by sex and three categories by age (6–11 months, 12–35 months, and 36–59 months), carried out in finding the associated factors of underweight in Putrajaya (Ahmad *et al.* 2021). The study took place in Putrajaya beginning from September 2018 until January 2019.

Sampling

Inclusion and exclusion criteria. The inclusion criteria were children aged 6 to 59 months old, Malaysian citizens, and a Putrajaya resident for no less than 6 months. The children with a mental or physical disability or ill during data collection and children with chronic diseases were excluded from joining the study.

Sample size estimation. The sample size was estimated based on the formula for comparing 2-Proportions (using PS software) according to an identified risk factor to underweight in NHMS 2016 data (maternal underweight) with type 1 error (α) of 0.05, and power (β) of 0.80. From the calculation, the minimum sample size required for each group was 318 (IPH 2016).

Recruitment and implementation. The ethical study approval was obtained from the Medical Research Ethics Committee (MREC), Ministry of Health Malaysia (NMRR-18-847-41455). Parental informed consent was obtained prior to the data collection. The case group consisted of children under five years with underweight (weight-for-age <-2SDs), and the control group consisted of children within the normal range for all growth indicators (weight-for-age, height-for-age, weight-for-height/length, and BMI-for-age between -2SDs to +2SDs z score

from the median). Screening for recruitment based on eligibility was done during Phase I (screening; 12th September 2018 to 12th October 2018) in preschools and all government health facilities in Putrajaya. During Phase II, trained nutritionists did the face-to-face interviews among caregivers between 16th October to 31st January 2019 to obtain information from caregivers/parents.

Data collection

Questionnaire. The tablet questionnaire contains seven modules that ask about sociodemographic and socioeconomic characteristics, the respondent's and his or her mother's health and medical record, knowledge and practise of parents or carers regarding child feeding, dietary behaviour of the children, Infant and Young Child Feeding (IYCF) history, food security, and screen time/physical exercise. The questions asked in this study were previously verified. The questionnaires were used for face-to-face interview with the respondents.

This set of questionnaires was used for assessing breastfeeding practices, history of breastfeeding, infant feeding and complementary diet. The questionnaire was adapted from WHO Global Consensus Meeting on Indicators of Infant and Young Child Feeding 2007 (WHO 2007). Meanwhile, three days of food intake of children were completed by the parent and caregiver with two days during weekdays and one day during the weekend. The quantities of all food and beverages consumed by the eligible child were recorded by the parent and caregiver in a given 3-days food diary using standard household measurements. For children who went to preschool during weekdays, the food intake at school was recorded by their teacher using a separate food diary form. The data collection team collected the 3-days food diary and separated food diary from preschool and probed during the second visit. The 3-day food diary data, however, is not presented in this paper. A mobile tablet with real-time data entry was utilized for face-to-face interviews to obtain all the relevant information. Data is saved online at the institute's local server in CSV format.

Anthropometric measurements. Tanita Personal scale HD 319 (TANITA Cooperation, Tokyo, Japan) and SECA Stadiometer 213 (SECA Cooperation, Humberg, German) was used to measure the body weight and body height of the children and their parents/caregivers (Baharudin *et al.* 2017). The measurements were

rounded to the nearest 0.1 kg for body weight and 0.1 cm for body height. For infants or children who were unable to stand properly, their weight was measured with SECA 354 digital baby scale and their length with SECA 210 mobile baby measuring mat. All measurements were taken twice, and the Survey Creation System (SCS) application recorded the readings. The tools were calibrated daily prior to data collection. For statistical analysis purposes, the study used the average weight and height values. The WHO Anthro Software version 3.2.2 was used to identify the nutritional status of respondents (WHO 2011).

Hemoglobin assessment. Hemoglobin assessment by trained nurses to all consented respondents using a portable HemoCue analyzer (HemoCue[®] Hb 201). The results of haemoglobin concentration were entered into the mobile device. A haemoglobin level of less than 11.0 g/dL was used to define anaemia in children (Ahmad *et al.* 2015; WHO 2011).

Dietary intake. Dietary intake of the respondents was assessed by the three days food diary. Their parents/caregivers were requested to fill in the food diary for two weekdays and one day over the weekend. Teachers from preschools were requested to record food intake during school time for pre-schoolers. The trained nutritionist performed a quality check of the food diaries prior to data entry.

Data management. Data were submitted to the server located in the Institute of Public Health (IPH) online. The data received by the server in CSV form were converted into SPSS format. Weekly deliveries of the food diaries were made to IPH. The team members in IPH keyed in the food intake of respondents into Nutritionist Pro Software version 7.5 for analysis of calories and nutrient intake.

Data analysis

Descriptive statistics were performed for all variables. Simple logistic regression was performed to determine the association between underweight and all independent variables. Variables with p-value <0.25 (Bursac *et al.* 2008) and clinically significant variables were included in the multiple logistic regression analysis. To provide a preliminary model, multicollinearity and interactions were tested. IBM SPSS Statistics for Windows, version 23.0 was used to perform the statistical analyses.

The three model fit assessments are the Hosmer-Lemeshow test, the Classification table, and the vice Area under Receiver Operating Characteristics (ROC) curve. The independent variables with p -value <0.05 were taken as associated factors of underweight status. Meanwhile, factors with odds ratio >1.00 were considered as risk factors and factors with odds ratio ≥ 1.00 were regarded as protective factors.

RESULTS AND DISCUSSION

About 1,516 (18.5%) children screened for the study were underweight. Among the underweight children, 845 (19.9%) were boys and 671 (16.9%) were girls. The study successfully recruited a total of 728 children (underweight=364, normal=364). From multiple logistic regression analyses, the preliminary final model found mid-parental height <150 cm, father's occupation in

the private sector, B40 household income group, monthly expenditure for childcare less than RM 1,000 (USD 234.06), underweight prepregnancy BMI, having low birth weight, being anaemic children, bottle feeding, using a pacifier and being taken care by babysitter while the parents were at work, were associated with underweight as described in Table 1.

More than half of the children from both case and control groups have parents with mid-parental height of 160 cm and above. Most parents in both case and control groups achieved tertiary education and were employed. However, more than half earned below the bottom 40 ($<RM 7,380$ (USD 1727.33)). In general, about half of the families spent ($<RM 1,000$ (USD 234.06)) on childcare. There was a higher proportion of children from the case group (15.7%) whose mothers were underweight during prepregnancy than children from the control group (6.9%).

Table 1. Factors associated with underweight among children under five years old in Putrajaya

Variables	Underweight n (%)	Normal n (%)	Simple logistic regression		Multiple regression	
			OR (95% CI)	<i>p</i>	AOR (95% CI)	<i>p</i>
Mid-parental height (cm)						
<150.0	27 (7.4)	11 (3.0)	2.68 (1.29–5.55)	0.008	3.03 (1.38–6.62)	0.006*
150.0–159.9	141 (38.7)	139 (38.2)	1.11 (0.82–1.50)	0.510	1.01 (0.73–1.40)	0.950
≥ 160.0	196 (53.8)	214 (58.8)	1		1	
Father's occupation						
Government servant	208 (57.1)	223 (61.3)	1			
Non-gov. servant	154 (42.3)	138 (37.9)	1.20 (0.89–1.61)	0.237	1.45 (1.04–2.02)	0.050*
Not working	2 (0.5)	3 (0.8)	0.71 (0.12–4.32)	0.714	0.37 (0.04–3.63)	0.392
Household income (monthly)						
B40 (Below 40%)	230 (63.2)	184 (50.5)	2.31 (1.14–4.66)	0.020	2.17 (1.01–4.66)	0.048*
M40 (Middle 40%)	121 (33.2)	156 (42.9)	1.43 (0.70–2.93)	0.325	1.59 (0.73–3.48)	0.243
T20 (Top 20%)	13 (3.6)	24 (6.6)	1		1	
Monthly expenditure for childcare						
<RM 1,000 (USD 234.06)	200 (54.9)	159 (43.7)	2.21 (1.34–3.65)	0.002	1.77 (1.01–3.10)	0.046*
RM 1,000–RM 1,999 (USD 468.61)	135 (37.1)	154 (42.3)	1.54 (0.92–2.57)	0.097	1.49 (0.85–2.61)	0.112
$\geq RM 2,000$ (USD 468.85)	29 (8.0)	51 (14.0)	1		1	
Pre-pregnancy BMI						
Normal	208 (57.1)	198 (54.4)	1		1	
Underweight	57 (15.7)	25 (6.9)	2.17 (1.30–3.61)	0.003	1.89 (1.10–3.26)	0.022*
Overweight or obese	99 (27.2)	141 (38.7)	0.67 (0.48–0.92)	0.014	0.72 (0.51–1.102)	0.062

Underweight children below five years: A case control

Continue from Table 1

Variables	Underweight n (%)	Normal n (%)	Simple logistic regression		Multiple regression		Logistic <i>p</i>
			OR (95% CI)	<i>p</i>	AOR (95% CI)	<i>p</i>	
Birth weight status							
Normal birth weight	286 (78.6)	340 (93.4)	1		1		
Low birth weight	78 (21.4)	24 (6.6)	3.86 (2.38–6.27)	0.001	3.25 (1.89–5.60)		0.001*
Children Hb status							
Normal	174 (47.8)	213 (58.5)	1		1		
Anaemic	190 (52.2)	151 (41.5)	1.54 (1.15–2.06)	0.004	1.57 (1.15–2.16)		0.005*
Use of pacifier							
Yes	318 (87.4)	296 (81.3)	1.59 (1.06–2.38)	0.026	1.75 (1.21–2.73)		0.014*
No	46 (12.6)	68 (18.7)	1		1		
Place of stay							
Kindergarten	233 (64.0)	291 (79.9)	1		1		
Babysitter	92 (25.3)	42 (11.5)	2.74 (1.83–4.10)	0.001	2.33 (1.52–3.59)		0.001*
Relative	39 (10.7)	31 (8.5)	1.57 (0.95–2.60)	0.078	1.30 (0.74–2.26)		0.357
MVPA time in a day							
<180 minutes	27 (7.4)	22 (6.0)	1.25 (0.70–2.23)	0.460	-		
≥180 minutes	337 (92.6)	342 (94.0)	1		-		

**p*<0.05 for logistic regression analysis Hosmer-Lameshow test=0.837 (>0.05); Classification table=63.7%, Area under Receiver Operating Characteristics (ROC) curve=0.712; AOR: Adjusted Odds Ratio; MVPA: Moderate to Vigorous Physical Activity; OR: Odds Ratio; B40 is household income <RM7,380 (<USD 1,727.33); M40 is household income between RM7,380–RM14,789 (USD1,727.33–USD3,461.44); T20 is house-hold income ≥RM14,790 (≥USD 3,461.44) ; 1RM=0.23USD;

Note: Variable added but not shown in table (mother’s education, mother’s occupation, father’s education, monthly expenditure for food, utility and transport, mother age during pregnancy, weight gain during pregnancy, complication during pregnancy, number of antenatal visits, child feeding knowledge, practice and behavior, delivery method, delivery status, birth length, birth head circumference, number of siblings, the age gap between elder and younger sibling, frequent illness, injury and worm infection, initiation breastfeeding, breastfeeding status, exclusive breastfeeding, predominant breastfeeding, age stop breastfeeding, formula milk, use of bottle feeding, MDD status, achievement of kcal intake, achievement of protein intake, food insecurity, sleep time, screen time, and MVPA time

There were 13.2% of children from the case group, and 6.2% of children from the control group delivered prematurely. A significantly higher proportion of underweight children were anaemic (52.2%) than normal children (41.5%).

A significantly higher proportion of underweight children (87.4%) were given pacifiers than normal children (81.3%). By childcare, a higher proportion of underweight children was found among those taken care of by babysitters or relatives. Multivariate analysis using logistic regression found that underweight children were associated with; short parental stature, low household income, less expenditure spent for childcare, underweight pre-pregnancy mother, low birth weight, anaemic children, and pacifiers' practice and being taken care of by a babysitter.

In general, there are nine risk factors significantly associated with being underweight among children under five years old. Our study found that Low Birth Weight (LBW) is the strongest risk factor for underweight. The finding from this study was comparable with the previous study conducted in Indonesia. A previous study reported higher proportion of Indonesian children with history of low-birth-weight were underweight compare to their counter part of normal birth weight (Kurnianingtyas *et al.* 2021). Several previous studies consistently reported that LBW is a significantly associated factor in being underweight in urban and rural areas (Utami *et al.* 2018; Ntenda 2019). On the other hand, a study reported that LBW was particularly caused by maternal health (Mumbare *et al.* 2012).

This study described that the children with short stature parents with a mid-parental height of less than 150 cm were three times more likely to become underweight than children with parents with a mid-parental height of 160 cm and above. This finding can be supported by a similar study from Korea reporting that children with lower mid-parental height also have lower weight (Suh & Kim 2020). However, an earlier study from Sweden reported only a weak association of mid-parental height with the child being underweight (Berglund *et al.* 2016). Nonetheless, mid parental height showed no significant association with underweight (Amin & Julia 2016). The World Health Organisation Multicentre Growth Reference Study (WHO MGRS) found that in situations with widely varied parental heights, mid-parental height consistently predicted a larger proportion of observed variability in attained child length (Garza *et al.* 2013). The current review on malnutrition and genetics highlights on the need of doing more research on malnutrition genetics to provide better understanding of the genetic risks of malnutrition, which may help identify ideal targets for malnutrition intervention and treatment (Duggal & Petri 2018).

Due to their working mothers, numerous children were placed under the care of babysitters at a young age. This current finding indicates a notable correlation between the babysitters' care and the prevalence of underweight children. This condition might be attributed to babysitters who cared for the babies/children only having lower formal education or lack of training in childcare compared to caregivers in kindergarten. In Malaysia, under the Act of Care Centers 1993 (ACT 506), caregivers must provide healthy, balanced, safe food for all children under their care (MoHM 2018). They must attend continuous training and short courses to provide professional care to the babies/children in kindergartens or nurseries. The caregivers are knowledgeable and experts in their field, understand well and perform nursing-related tasks according to established standards (Department of Social Welfare 2020). Nutrition Division and Department of Social Welfare Malaysia provided a Summary of the Menu Planning Guide at the Care Centre to ensure the quality of meals provided in children's centres (MoHM 2018). This indicates that the complementing purpose of outstanding childcare in preschools and day care institutions is critical in decreasing malnutrition in people with

limited resources. A survey conducted in Cyprus found that a higher percentage of children were undernourished when cared for by babysitters. The study also reported that more children that were cared for by babysitters were underweight than those cared for by others. Babysitters may not provide the child with the appropriate nutritional support needed (Mousa 2018).

Furthermore, in our study, children with underweight status were significantly associated with low household income and the least monthly expenditure. An important factor was underlying most of the determinants of underweight children in poverty. This outcome was consistent with earlier research from low- and middle-income nations (Fagbamigbe *et al.* 2020; Kanjilal *et al.* 2010). Generally, individuals residing in poorer households are usually unable to achieve food security (Kimani-Murage 2013) and are less likely to spend money on childcare. Evidence from other studies suggests that low-income status may reduce the accessibility to healthier foods, hence consuming healthy foods (Nackers & Appelhans 2013).

In this current study, low maternal prepregnancy weight was significantly associated with underweight children and was consistent with the previous studies, which determined low maternal prepregnancy BMI on the physical growth of the children (Li *et al.* 2018). The BMI of mothers was considerably high and strongly correlated with the nutritional health of their children, according to a study on 246 mothers in North Bengal, India (Tigga & Sen 2016). Despite that several studies from developed countries were concentrating on the association between high maternal prepregnancy BMI (overweight or obesity) and offspring obesity and intellectual development (Yu *et al.* 2013; Veena *et al.* 2016) study on prepregnancy underweight and associated outcomes are still rarely considered (Li *et al.* 2018). Our findings revealed that gaining ideal weight before pregnancy among women is very important in preventing underweight status among children in order to maintain optimum growth of children (Gul *et al.* 2020).

The use of a pacifier, mostly in young child feeding practice, is identified as a risk for underweight rather than bottle feeding and those who do not achieve Minimum Dietary Diversity (MDD). The previous study reported that pacifier usage among young children would lead to a shorter duration of breastfeeding and reduced

food intake (Campos *et al.* 2018). In addition, infants or children exposed to bottles or pacifiers were more likely to have Oral Motor Dysfunction (OMD). This study also revealed a significant association between fathers' employment in the non-government sector and underweight children. Another Korean study could support this finding that reported poor household socioeconomic conditions (household wealth) were the strongest factors in most countries (Li *et al.* 2020). However, we did not find the same association between mothers' employment and underweight children. These results could not be compared to those of an earlier study carried out in Ludhiana, Punjab. The previous study found that most children with normal weight have fathers working in the private sector. Hence a father's occupation affects a child's nutritional status (Kaur *et al.* 2017).

An association between being underweight and anemia was observed in our study. A similar association was seen in a study conducted among children in rural areas of Shaanxi province in northwestern China showed that the prevalence rate of underweight among 118 infants with anemia was 45.3% (Yang *et al.* 2012) while a study done in two areas in Ethiopia: Eastern Oromia (Babbe District) and South-Central Tigray (Enderta & Hintalo Wajirat Districts) showed that 66.7% underweight children were anemic (Roba *et al.* 2016).

Additionally, there were a number of issues with this study. There was a lack of diversity in the sociodemographic background of the respondents because their parents were mainly employed in the government sector, and most of them were Malay. This was a case-control study with the design allowing us to look at multiple risk factors at one time. The findings of this study provide necessary facts to stakeholders and policymakers to develop/plan interventions towards reduction in the prevalence of underweight children in Putrajaya.

CONCLUSION

According to our findings, nine factors such as low birth weight, mid parental height less than 150 cm, taken care by a baby sitter, B40 household income, underweight mother, monthly child expenditure for children less than RM 1,000, using of a pacifier, father working in non-government agencies and children with anemia

are significantly associated to underweight. These findings may point to potential causal factors that may have an impact on the underweight problem among younger children, such as low socioeconomic status, inadequate prenatal care, a lack of education or knowledge about baby and young child feeding practises. This study and its findings provide stakeholders and policymakers with convincing evidence for taking appropriate measures to address and improve household socioeconomic status; maternal nutritional status; and infant and young child feeding practices in preventing the underweight issues among youngsters especially children under five years old in Putrajaya.

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DECLARATION OF CONFLICT OF INTERESTS

These authors declare that there is no conflict of interest in any form.

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