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Factors associated with stunting among *Orang Asli* preschool children in Negeri Sembilan, Malaysia

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ABSTRACT

Introduction: Childhood stunting is recognised as one of the most significant barriers to human development. This cross-sectional study aimed to determine the factors associated with stunting among *Orang Asli* (OA) preschool children in Negeri Sembilan, Malaysia. **Methods:** A total of 264 children (50.9% boys and 49.1% girls) aged 2-6 years (M=4.04, SD=1.21 years) including their mothers from 14 OA villages in Negeri Sembilan participated in this study. Mothers were interviewed to obtain information regarding socioeconomic status, sanitation facility and personal hygiene. The height of the children and their mothers were measured. Venous blood samples were drawn from the children to estimate haemoglobin level, and stool samples were collected to screen for intestinal parasitic infections. **Results:** Approximately one third of the children (35.6%) and 7.8% of the mothers were stunted. One in five of the children were anaemic (21.6%), while one- third had intestinal parasitic infections (35.0%). Low birth weight (AOR=2.526, 95% CI: 1.310-4.872; p=0.006), anaemia (AOR=2.742, 95% CI: 1.265-5.945; p=0.011), presence of intestinal parasitic infections (AOR=2.235, 95% CI: 1.310-3.813, p=0.003), not wearing shoes (AOR=2.602, 95% CI: 1.453-4.660; p=0.001), absence of piped water at home (AOR=2.395, 95% CI: 1.047-5.476; p=0.039), dirty nails (AOR=1.956, 95% CI: 1.163-3.289, p=0.011), and stunted mothers (AOR=3.443, 95% CI: 1.334-8.890; p=0.011) were identified as significant factors for childhood stunting. **Conclusion:** It is suggested that the factors identified associated with childhood stunting be included in future intervention programmes that address stunting among OA children.

Keywords: Haemoglobin level, sanitation and hygiene, maternal stature, parasitic infection, stunting, *Orang Asli* children

INTRODUCTION

Malnutrition, specifically protein-energy malnutrition, exposes children to increased risk of morbidity and mortality. Indeed, it is a serious cause which impedes child growth and development (UNICEF / WHO / World Bank Group, 2017). Basically, stunting, which is one of the various forms of malnutrition, is defined as height-for-age z-score (HAZ) of less than -2 standard deviation (SD) below the median of a reference standard (WHO, 2006). It is a well-established indicator of chronic undernutrition which shows long-term,

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cumulative insufficiencies of nutrition and suboptimal health condition that is often due to maternal undernutrition (WHO, 2006).

Globally, the prevalence of childhood stunting has decreased from 32.7% in 2000 to 22.9% in 2016, but it is declining too slowly (UNICEF/WHO/World Bank Group, 2017). Notwithstanding the decline in prevalence of stunting, an estimated 155 million children worldwide below the age of 5 were stunted, with more than half from Asia (UNICEF/WHO/World Bank Group, 2017). With respect to this matter, indigenous people continue to be among the most underprivileged population stricken with deprived health and social outcomes. Moreover, several studies have shown that indigenous children had high prevalence of stunting. For example, the prevalence of stunting was 63.7% in Guatemala (Ramirez-zea *et al.*, 2014), 50.0% in Peru (Anticona & San Sebastian, 2014), and 25.7% in Brazil (Horta *et al.*, 2013).

In 2015, indigenous peoples were approximately 13.8% of the 31,660,700 population in Malaysia. Specifically, in Peninsular Malaysia, indigenous peoples are known as *Orang Asli* (OA), accounting for 210,000 or 0.7% of the 31,005,066 population (Hansen, Jepsen & Jacquelin, 2017). The OA community has distinctive language, cultures and beliefs. Most of these people are hardcore poor and have relatively low socioeconomic status, lack of healthcare awareness, poor sanitation facilities, and unable to provide essential needs such as appropriate clothings and nutritious food for the whole family (Masron *et al.*, 2013). Despite the fact that most Malaysians are categorised under the upper middle-income group, the majority of OA population in Peninsular Malaysia are still struggling with poverty, poor nutritional and health status, especially in young children (Ahmed *et al.*, 2012; Chua *et al.*, 2012; Wong *et al.*, 2015). Overall, the poverty among Malaysians had significantly reduced from 3.8% in 2009 to 0.6% in 2014, but poverty rates among OA population remained high at 34.0% (EPU, 2016). In relation to this finding, OA is ascertained to be among the poorest populations in Malaysia.

Stunting in OA children, especially those below the age of 5, is one of the main concerns of public health in Malaysia. In this context, several studies in Malaysia showed that the prevalence of stunting among the OA children were in the range of 40-76% (Ahmed *et al.*, 2012; Chua *et al.*, 2012; Wong *et al.*, 2018). Clearly, this indicates that these children have a higher tendency to get common infections and diseases such as anaemia later in life, as well as jeopardising their cognitive development. A previous study showed that stunting has a long term adverse effect on adult cognitive ability, reduces school attainment, and limits income levels (Hoddinott *et al.*, 2013).

There are multiple factors known to be associated with stunting such as poor socioeconomic status (Rahman *et al.*, 2016), poor sanitation (Alelign, Degarege & Erko, 2015; Rah *et al.*, 2015), low level of haemoglobin (Al-Qaoud, Al-Shami & Prakash, 2015; Leite *et al.*, 2013), stunted mothers (Walker *et al.*, 2015) and intestinal parasitic infections (Ahmed *et al.*, 2012; Sanchez *et al.*, 2013). Although the prevalence of stunting in OA children were well-documented, its specific determinants toward stunting are inconclusive. Therefore, this study aimed to identify the factors associated with stunting among OA preschool children in Negeri Sembilan.

MATERIALS AND METHODS

Study setting and subjects

A cross-sectional study was conducted among OA children aged 2-6 years in the state of Negeri Sembilan, Malaysia from April 2015 to January 2016. Out of seven districts in Negeri Sembilan, two districts were purposely selected due to the high number of OA villages, namely Jempol (16 villages) and Kuala Pilah (14 villages). However, only 14 (six from Jempol and eight from Kuala Pilah) out of 30 villages agreed to participate in this study. The other 16 villages did not participate in this study due to several reasons, including no preschool children, no leader (*Tok Batin*) and not allowing outsiders to enter village due to villagers' behaviours and culture of not talking and mixing with outsiders. From these 14 participated villages, a list of 280 children aged 2-6 years old was obtained from the *Tok Batin* from each village. Overall, 264 children completed the questionnaires and measurements of the study with an overall response rate of 94.3%. Ten parents refused to let their children to participate in this study while another six children had moved to other villages.

Procedures

In order to conduct this study, ethics approval was first obtained from the Ethics Committee for Research Involving Human Subjects (JKEUPM) of Universiti Putra Malaysia [Reference No.: FPSK (FR15) P001]. This study was conducted under the permission obtained from the Department of Orang Asli Development (JAKOA) [Reference No.: JAKOA/ PP.30.032Jld31(05)]. Written informed consent forms were acquired from the mothers prior to the data collection.

There were two visits conducted in the OA villages. During the first visit, stool samples of the children were collected while the mothers were interviewed to complete a questionnaire. In the following visit, respondents were gathered in a village hall for blood withdrawal by a paediatrician and anthropometric measurements by the researchers.

Instruments

Face-to-face interview

Socioeconomic background

In this study, a face-to-face interview was conducted using a Malay language questionnaire which required the mothers to provide information on socioeconomic background, including age, sex, sub-tribe, child's birth weight, household size, parents' education level, occupation status, and monthly household income.

Sanitation and hygiene

Personal hygiene and sanitation facilities' questionnaires were adapted from Al-Delaimy et al. (2014) and assessed in this study through two methods, namely observation and interview. During the home visit, observations were focused on the personal hygiene of the children. For example, the practice of cutting fingernails and wearing shoes outside the house were taken into account. On the other hand, both interviews and observations were conducted to inquire about sanitation facilities with regards to the availability of functioning toilets and piped water at home. A binary-choice (yes/no) style was utilised.

Haemoglobin concentration

Haemoglobin (Hb) concentration of children was measured through 3 ml of venous blood sample withdrawn by a paediatrician. Specifically, anaemia in children under age of 5 years is defined when Hb concentration is <11g/dL, whereas, anaemia for children 5 years and above is defined when Hb concentration is <11.5 g/dL (WHO, 2011). Mild anaemia is defined when Hb concentration is between 10.0-10.9 g/dL for children under 5 years and 11.0-11.4 g/dL for children 5 years and above. Moderate anaemia is defined when Hb concentration is between 7.0-9.9 g/dL for children under 5 years and 8.0-10.9 g/dL for children 5 years and above. Severe anaemia is defined when Hb concentration less than 7 g/dL for children under 5 years and less than 8 g/dL for children 5 years and above (WHO, 2011). All laboratory analyses were then outsourced to an accredited laboratory.

Parasitic infections

Mothers were asked to scoop a fresh, thumb-sized stool sample from their children without any urination, water or sand, and to store it in a stool container that was provided to them. Mothers informed the person in charge of each village to contact the researcher via phone to collect the stool sample. The stool samples were put in a suitable ice box and transported to an accredited laboratory for further analysis. The transportation time took between 30 minutes to one hour to reach the laboratory. In the laboratory, stool samples were analysed to check for the presence of intestinal parasites, namely *Trichuris trichiuria* and *Ascaris lumbricoides*. Particularly, direct microscopy (iodine) method was employed to analyse the presence of intestinal parasites.

Anthropometric measurement

Anthropometric measurements were conducted on the children and their mothers. Height was measured by using a SECA body meter 206 (SECA, Germany) and rounded to the nearest 0.1 cm whereas weight was measured by using a TANITA Digital Weighing Scale HD-314 (TANITA Corporation, USA) to the nearest 0.1 kg. Duplicate results were obtained and the average of the duplicate results was recorded. Based on the results gathered, the mean *z*-score for height-for-age (HAZ) for children was computed according to the WHO Growth Reference 2007 (≥5 years old) and WHO Child Growth Standards 2006 (<5 years old) (WHO, 2006, 2007) by using the WHO AnthroPlus Version 1.0.4 software (WHO, Geneva, Switzerland). Mothers with height shorter than 145 cm were considered as stunted (Subramanian *et al.,* 2009).

Statistical analysis

The analysis of data was performed using IBM SPSS Statistics 22.0 (IBM Corp., Armonk, NY, USA). The distributions for quantitative variables were checked for normality. Univariate analysis was applied to analyse descriptive data for all variables in this study. Besides, the chi-square test was used to determine the associations between categorical variables and stunting. Additionally, binary logistic regression analysis was performed to determine the risk factors of stunting. All variables that possessed a $p<0.25$ in the simple logistic regression analysis were included in the multiple logistic regression analysis. This criterion of $p<0.25$ was employed based on the evidence proposing that the threshold ($p<0.05$) might exclude variables which are significant (Hosmer & Lemeshow, 1989). The acceptable level of statistical significance for all tests was set at $p<0.05$.

RESULTS

Table 1 shows the characteristics of the study respondents. The prevalence rates of severely stunted and stunted children were 6.4% and 29.2%, respectively. The mean age of the OA children was 4.04±1.21 years, ranging from 2 to 6 years. Majority of the children (59.1%) were of the Temuan sub-tribe. More than half (54.9%) of the respondents had household size of 5-8 family members.

More stunted children had low birth weight and were anaemic (mild, moderate, and severe) as compared to non-stunted children (Table 1). In terms of intestinal parasitic infections, 10 children refused to provide stool samples. Out of 254 stool samples,

Table 1. Sociodemographic characteristics, haemoglobin level, and intestinal parasitic infections of the respondents (*n*=264)

Characteristics	*n (%)*			X^2	*p-value*
	Total (n=264)	*Stunted (n=97)*	*Non-stunted (n=167)*		
Children					
Sex				0.001	0.979
Boy	135 (51.1)	49 (50.5)	86 (51.5)		
Girl	129 (48.9)	48 (49.5)	81 (48.5)		
Age (years)				0.035	0.852
Toddlers (2-3)	92 (34.8)	35 (36.1)	57 (34.1)		
Pre-schoolers (4-6)	172 (65.2)	62 (63.9)	110 (65.9)		
Sub-tribe				6.499	0.039*
Temuan	156 (59.1)	54 (55.7)	102 (61.1)		
Semelai	96 (36.4)	42 (43.3)	54 (32.3)		
Others	12 (4.5)	1 (1.0)	11 (6.6)		
Birth weight (kg)				5.876	0.015*
Low (<2.5)	54 (20.5)	28 (28.9)	26 (15.6)		
Normal (≥2.5)	210 (79.5)	69 (71.1)	141 (84.4)		
Education				0.441	0.507
No schooling	144 (54.5)	56 (57.7)	88 (52.7)		
Pre-school	120 (45.5)	41 (42.3)	79 (47.3)		
Household size (members)				3.056	0.217
1-4	94 (35.6)	35 (36.1)	59 (35.3)		
5-8	145 (54.9)	49 (50.5)	96 (57.5)		
9-19	25 (9.5)	13 (13.4)	12 (7.2)		
Haemoglobin (g/dL)				7.900	0.019*
Normal	207 (78.4)	67 (69.1)	140 (83.8)		
Mild anaemia	34 (12.9)	18 (18.6)	16 (9.6)		
Moderate/severe anaemia	23 (8.7)	12 (12.4)	11 (6.6)		
Parasite infection (*n*=254)				8.876	0.003*
Yes	89 (35.0)	44 (47.3)	45 (28.0)		
No	165 (65.0)	49 (52.7)	116 (72.0)		
Types of parasites				0.135	0.935
Trichuris trichiuria only	47 (52.8)	24 (54.5)	23 (51.1)		
Ascaris lumbricoides only	10 (11.2)	5 (11.4)	5 (11.1)		
Both	32 (36.0)	15 (34.1)	17 (37.8)		
Parents					
Education levels					
Father (*n*=250)				4.640	0.098
No schooling	33 (13.2)	12 (13.0)	21 (13.3)		
Primary school	126 (50.4)	54 (58.7)	72 (45.6)		
Secondary school	91 (36.4)	26 (28.3)	65 (41.1)		
Mother				6.897	0.032*
No schooling	34 (13.0)	12 (12.4)	22 (13.5)		
Primary school	113 (42.5)	52 (53.6)	61 (37.4)		
Secondary school	117 (44.5)	33 (34.0)	80 (49.1)		
Household income (RM)				6.242	0.044*
≤580†	101 (38.3)	44 (45.4)	57 (34.1)		
581–940‡	76 (28.8)	30 (30.9)	46 (27.5)		
>940	87 (33.0)	23 (23.7)	64 (38.3)		
Income per capita (RM)				9.187	0.010*
≤140†	142 (53.8)	62 (63.9)	80 (47.9)		
141-240‡	61 (23.1)	22 (22.7)	39 (23.4)		
>240	61 (23.1)	13 (13.4)	48 (28.7)		
Maternal height (cm)				5.094	0.024*
<145	21 (8.0)	13 (13.4)	8 (4.8)		
≥145	243 (92.0)	84 (86.6)	159 (95.2)		

RM = Ringgit Malaysia
†Hard core poverty income (Economic Planning Unit, 2014)
‡Poverty income (Economic Planning Unit, 2014)
*Chi-square test, significant at p<0.05

Table 2. Sanitation and hygiene of the children

Variables	*n (%)*			X^2	*p-value*
	Total (n=264)	*Stunted (n=97)*	*Non-stunted (n=167)*		
Personal hygiene					
Wash hands using soap				1.149	0.284
Yes	199 (75.4)	69 (71.1)	130 (77.8)		
No	65 (24.6)	28 (28.9)	37 (22.2)		
Wearing shoes outside house				9.613	0.002*
Yes	201 (76.1)	63 (31.3)	138 (82.6)		
No	63 (23.9)	34 (35.1)	29 (17.4)		
Nails cleanliness				6.513	0.011*
Yes	169 (64.0)	52 (53.6)	117 (70.1)		
No	95 (36.0)	45 (46.4)	50 (29.9)		
Sanitation facilities					
Presence of toilet				4.135	0.042*
Yes	82 (31.1)	59 (60.8)	123 (73.7)		
No	182 (68.9)	38 (39.2)	44 (26.3)		
Presence of piped water				4.854	0.028*
Yes	234 (88.6)	80 (82.5)	154 (92.2)		
No	30 (11.4)	17 (56.7)	13 (7.8)		

*Chi-square test, significant at $p<0.05$

35.0% of the children were infected with intestinal parasites. Majority of the children were infected by *Trichuris trichiuria* (52.8%) (47/89), followed by *Ascaris lumbricoides* (11.2%) (10/89) while 36.0% (32/89) were infected by both. More stunted children were infected by intestinal parasites (47.3%) as compared to non-stunted children (28.0%, p=0.003), but there was no significant association between the types of parasite and stunting. Mothers with no schooling (X^2=6.897, p=0.032), low household income (X^2=6.242, p=0.044), low income per capita (X^2=9.187, p=0.010) and short stature (X^2=5.094, p=0.024) were significantly associated with childhood stunting.

There was a higher percentage of stunted children who did not wear their shoes outside the house (35.1%) compared to non-stunted children (17.4%; p=0.002) (Table 2). Among the stunted children, there was a greater percentage of children who had dirty nails (46.4%) compared to non-stunted children (29.9%; p=0.011). Besides, more stunted children did not have toilet facility at home (p=0.042) and functioning water pipes (p=0.028) compared to non-stunted children. However, there was no significant association between hand washing using soap and stunting.

Table 3 outlines the binary logistic regression for unadjusted and adjusted odds ratios (OR). After the data were adjusted for age, sex, mother's education, household size and monthly household income, the logistic regression analysis results showed that child's birth weight, anaemia status, presence of parasitic infections, maternal stature, not wearing shoes outside the house, having dirty nails, and absence of piped water at home were significantly associated with stunting in OA children. In fact, children with stunted mothers were 3.443 times (95% CI: 1.334-8.890;

Table 3. Unadjusted and adjusted odds ratios (OR) and 95% confidence intervals (CIs) among stunted and non-stunted children

Variables	*Unadjusted*			*Adjusted*†		
	OR	*95% CI*	*p-value*	*OR*	*95% CI*	*p-value*
Birth weight (g)						
Normal	1.00			1.00		
Low	2.201	1.200-4.036	0.011	2.526	1.310-4.872	0.006*
Maternal stature						
Normal	1.00			1.00		
Stunting	3.076	1.226-7.715	0.017	3.443	1.334-8.890	0.011*
Haemoglobin level						
Normal	1.00			1.00		
Mild anaemia	2.351	1.129-4.896	0.022	2.742	1.265-5.945	0.011*
Moderate & severe anaemia	2.280	0.957-5.432	0.063	2.171	0.893-5.274	0.087
Presence of parasites						
Negative	1.00			1.00		
Positive	2.315	1.358-3.945	0.002	2.235	1.310-3.813	0.003*
Wash hands using soap						
Yes	1.00					
No	1.426	0.805-2.524	0.224	-	-	-
Wearing shoes outside house						
Yes	1.00			1.00		
No	2.568	1.441-4.578	0.001	2.602	1.453-4.660	0.001*
Nails cleanliness						
Yes	1.00			1.00		
No	2.025	1.206-3.401	0.008	1.956	1.163-3.289	0.011*
Presence of toilet						
Yes	1.00					
No	1.800	1.056-3.070	0.031	-	-	-
Presence of piped water						
Yes	1.00			1.00		
No	2.517	1.164-5.442	0.019	2.395	1.047-5.476	0.039*

OR = Odds ratio; CI = Confidence Interval

†Data were adjusted for age (months), sub-tribe, sex, mother's education, household size, and monthly household income

*Significant at $p<0.05$

p=0.011) more vulnerable to stunting, compared to children with non-stunted mothers. Children with low birth weight were 2.526 times (95% CI: 1.310-4.872; p=0.006) more likely to become stunted as compared to children with normal birth weight.

Anaemic children were 2.742 times (95% CI: 1.265-5.945; p=0.011) more likely to become stunted, compared to non-anaemic children. Furthermore, children infected with parasites were 2.235 times (95% CI: 1.310-3.813, p=0.003) more likely to become stunted, compared to non-infected children. Children who did not wear shoes were 2.602 times (95% CI: 1.453-4.660, p=0.001) more likely to become stunted, compared to those children who wore shoes outside the house. Children with dirty nails were 1.956 times (95% CI: 1.163-3.289, p=0.011) more likely to become stunted as compared to those children with clean nails. Families without piped water inside the house were 2.395 times (95% CI: 1.047-5.476, p=0.039) more likely to have stunted children, compared to those with piped water.

DISCUSSION

This study showed a high prevalence of stunting (35.6%) among the OA children. The prevalence obtained in this study was comparatively higher than a study conducted among OA children in Raub, Pahang which reported 28.0% (Ahmed *et al.*, 2012). In contrast, a few other studies presented a higher prevalence of stunting among OA children, ranging from 41.0% to 64.0% (Chua *et al.*, 2012; Geik, Sedek & Awang, 2016; Wong *et al.*, 2015). The difference might be due to factors including locations and sub-tribes studied. The current study included mainly Temuan, while other studies included Jah-hut and Temiar sub-tribes. The Jah-hut and Temiar usually live close to or in the forest and are involved in gathering and hunting, while the Temuan adopt agriculture practices and manages their own rubber or oil palm (Masron *et al.*, 2013). According to Anuar *et al.* (2012), the Temuan have better housing conditions and provision of basic amenities, compared to the Jah-hut and Temiar. Nevertheless, the high prevalence of stunting in this study reflects the persistence of poor nutrition and the high prevalence of infections among the OA children (Chua *et al.*, 2012; Geik *et al.*, 2016).

Consistent with previous studies (Subramanian *et al.*, 2009; Felisbino-Mendes, Villamor & Velasquez-Melendez, 2014), the present study showed that stunted growth of mothers was closely associated with stunting in children. According to a related finding, mothers of short stature were discovered to produce children with short height (Felisbino-Mendes *et al.*, 2014). The association between low maternal height and childhood stunting may be explained by as the shorter mothers having a smaller uterine size which may lead to inadequate nutrient supply to the foetus (Zhang *et al.*, 2007). Consequently, this may also result in biological changes including membrane stretching and cervical restriction that increase the possibility of preterm delivery, low birth weight, and other health outcomes (Subramanian *et al.*, 2009). This association suggests an intergenerational transfer of poor health from mothers to their children (Subramanian *et al.*, 2009).

This study also showed that children with low birth weight had higher likelihood to become stunted. The tendency of children with low birth weight having poorer height status was reported in other studies (Wong, Moy & Sulochana, 2014; Rahman *et al.*, 2016). For instance, Rahman *et al.* (2016) explained that children with low birth weight had significantly increased risk of malnutrition after controlling for confounders. Similarly, low birth weight was significantly associated with malnutrition among Malaysian children (Wong *et al.*, 2014). As mentioned earlier, biological changes of stunted mothers could be one of the reasons that might increase the risk of low birth weight and the occurrence of malnutrition. One possible link identified between these variables was low birth weight children are more susceptible to various infections, diseases, loss of appetite, and poor nutrition as compared to normal birth weight children (Rahman *et al.*, 2016).

The association between children's haemoglobin levels and stunting was significantly shown in the present study, even after controlling the confounding variables. A similar association was observed in several other studies. For instance, Leite *et al.* (2013) presented that height-for-age was associated with anaemia among indigenous children in Brazil. Another study found that Kuwaiti preschool children aged 4-5 years who were moderately and severely stunted were 2.3 times more prone to be anaemic (Al-Qaoud *et al.*, 2015). According to Leite *et al.* (2013), stunting and anaemia are usually affected by a set of common causes including socioeconomic status, sanitation and parasitic disease.

The current finding depicted that parasitic infection was significantly related with stunting whereby the majority were infected by *Trichuris trichuria*. However, no significant association between the types of parasites and stunting was found and this is inconsistent with other studies. Sanchez *et al.* (2013) revealed that children with more than one parasites and moderately susceptible to heavy infections were associated with decreasing weight-for-age and height-for-age. Another study among OA school children in Raub, Pahang also depicted that *Ascaris* and *Trichuris* infections were significant predictors for stunting (Ahmed *et al.*, 2012). Parasitic infections were common in the OA children due to their exposure to impoverished living conditions such as poor sanitation and hygiene, poor housing and overcrowding problem. It is also important to note that heavily infected children usually have reduced appetite and poor absorption of micronutrients such as iron and iodine, which eventually leads to stunting (Hall, Hewitt, Tuffrey & De Silva, 2008).

With respect to sanitation facility and personal hygiene, it was found that children who did not wear shoes outside their house, did not have piped water inside the house and had dirty nails were at a significantly higher likelihood of becoming stunted, compared to non-stunted children. Similar to these findings, Wolde, Berhan & Chala (2015) reported that children with poor personal hygiene exhibited higher likelihood to become stunted. Poor sanitation and hygiene also increase the vulnerability of the children to parasitic infections which might cause them to have poor appetite and nutrition-deficient. On the other hand, findings revealed that hand washing using soap and availability of toilet were not significantly associated with stunting. This is in line with the findings of a study among OA pre-schoolers in Gua Musang, Kelantan, where presence of toilet was concluded to be not significantly associated with stunting (Geik *et al.*, 2016). This is mainly due to their habit of not utilising the toilet. Instead, the drain, river or bushes seems more preferable for their daily defecation. However, the children in this study were not affected by this practice as there exists a possibility of their parents cleaning them up after defecation, thus reducing the risk of infection (Geik *et al.*, 2016).

As this was a cross-sectional study, the causality between factors associated with childhood stunting could not be established. As haemoglobin concentration was used as a proxy indicator of anaemia, further studies should include serum ferritin and iron as indicators in order to identify the different types of anaemia. A sufficiently sensitive technique should be used in the future to increase parasite detection rate particularly with light infections. Egg counts should also be included in the future studies to determine the intensity of parasitic infections.

Despite these limitations, the current study has specific identified contributing factors to childhood stunting in indigenous populations, which may be useful for interventions to improve the nutritional status of OA children.

CONCLUSION

Childhood stunting remains a significant public health concern among OA children. This study highlighted early nutrition and environmental factors were crucial aspects in connection with stunting in OA children. Therefore, these identified factors should be addressed in nutrition improvement programmes for OA children.

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Authors' contributions

Siti Fatihah M, carried out data collection, data analysis, data interpretation, and drafted the manuscript; Gan WY, principal investigor, conceptualized and designed the study, collected data, prepared the draft of the manuscript and reviewed the manuscript; Norhasmah S, assisted in drafting of the manuscript and reviewed the manuscript; Zalilah MS, assisted in drafting of the manuscript, reviewed the manuscript.

Conflict of interest

The authors have no conflict of interest.

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