ORIGINAL ARTICLE

The Prevalence and Risk Factors of Iron Deficiency Anemia among Rural School children in Kudat, Sabah

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ABSTRACT

Introduction: Iron deficiency anaemia (IDA) is the most common nutritional anaemia in the world that affects individuals in both developed and developing countries including Malaysia. The prevalence of IDA among schoolchildren is crucial to know as IDA may contribute to poor mental and school academic performance. Hence, the objective of the study was to diagnose the present prevalence of IDA and to analyse the association with probable risk factors. **Methods:** This cross-sectional study was carried out from August 2017 to February 2018 among 261 school children, who aged between 8 to 10 years in Kudat, Sabah, were selected through simple random sampling. After getting informed consent from the parents or guardians of the participants self-administered validated questionnaire was used to gather information regarding socio-demographic data, knowledge, attitude and practice towards iron deficiency anaemia and Food Frequency Questionnaires. The blood sample was collected for confirmation of anaemia through serum haemoglobin (Hb) concentration and determination of iron status through serum ferritin, serum iron and serum TIBC and stool samples were collected for children identified with anaemia for soil-transmitted helminths analysis. **Results:** Out of 82 anaemic students, 36 were suffering from iron deficiency anaemia. The BMI status, the presence of soil-transmitted helminths and level of knowledge regarding IDA had highly significant ($p<0.001$) association with prevalence of IDA. **Conclusion:** By improving the household economy, education, sanitation, and personal hygiene status and promoting consistent nutritional education among the population may help to reduce the prevalence of IDA.

Keywords: Iron deficiency anaemia (IDA), Prevalence, Risk factors, Cross-sectional study, Malaysia

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INTRODUCTION

Iron deficiency anaemia (IDA) is the most common nutritional anaemia in the world that affects individuals in both developed and developing countries including Malaysia (1). In global studies, about 20% to 50% of anaemia cases have been reported and half of the cases are due to the iron deficiency (1, 2). In general, the prevalence of anaemia and iron deficiency anaemia (IDA) in the developing countries is three to four times higher than that in developed countries (1). It has been reported that children in South Asia have the highest rate with 50% and African children with 49% (3).

Anaemia is a medical condition that continues to be a major public health concern deserving of sustained public health intervention in many developing countries, especially in rural communities. Anaemia is defined as a reduced red blood cell count which leads to impairment of oxygen delivery to body tissues (4). Further depletion of iron storage in the body leads to IDA; haemoglobin (<11.5g/dl), reduced mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) and alteration at least one iron status indicator (5). Several studies on IDA highlighted that the problem of IDA is most common among infants, children, and women of childbearing age (1, 3, 6). It is an important cause for decreased attention span, reduced alertness and learning difficulties in both children and adolescent (2, 7, 8).

Several previous studies demonstrated a clear correlation between iron deficiency anaemia and a series of determinants in demographic, socio-economic, nutritional status and soil-transmitted helminths exposures. Low household income (9), large family size, parental employment status (10, 11), low level of education among parents (12, 13), inadequate level of knowledge, attitude and practice especially in hygiene and sanitation practice which may lead to soil-transmitted helminths exposures (14, 15). Low consumption of heme-iron food such as meat and vegetables that high

in iron together with high intake of dairy products created interaction with inhibitors which decrease iron absorption in the body (16). In Malaysia, several studies on IDA have been conducted. However, most of the studies are focusing on young children and women in childbearing ages (6, 17, 18). In Sabah, even though study on the prevalence of IDA has been conducted previously (6), there is a paucity of data regarding the prevalence of IDA among schoolchildren. The data of IDA among schoolchildren is crucial in order to know the iron status of the school children and its associated risk factors as IDA may contribute to poor mental and school academic performance. Hence, the objective of the study was to diagnose the present prevalence of IDA and to analyse the association of probable risk factors such as demography, socio-economic condition, nutritional status, soil-transmitted helminths exposure and level of knowledge, attitude and practice among the schoolchildren.

MATERIALS AND METHODS

Study design and setting

This cross-sectional study was carried out from August 2017 to February 2018, in Kudat district, Sabah. The areas were chosen due to their homogenous nature of populations in these villages with respect to their socio-cultural and daily economic activities which was considered appropriate for this study. In addition, the areas were considered as remote with poor socio-economic conditions and a high potential of malnutrition and possible soil-transmitted helminths infestations. Most people residing in these areas were farmers, fishermen, labour workers and self-employed. The main source of water for drinking and domestic usages was collected from rainwater and the rivers located adjacent to the villages. There was no proper sanitation in these communities.

Sample size and sampling technique

The sample size was determined using the formula: n = t2 * (p*q) / d2, where n = sample size, t (error risk) = 1.96, p (expected prevalence) = 0.2, q (1-p) = 0.8, d (absolute precision) = 0.05. (19). A sample size of 245 was calculated by taking anaemia cases globally according to the World Health Organization (WHO) latest data as a reference to the current study of iron deficiency anaemia (20). The considered precision was 5%. Hence, a total of 300 students including 20 percent possible dropout participants (245 people + 20% possible drop out participant 294 ≅ 300) have been determined as a sample size of the study.

Six rural schools were randomly selected from the list provided by Kudat District Education Office. A list of total numbers of students aged from 8 to 10 years old was asked beforehand from the schools to ensure numbers of targeted students were met.

A short briefing was conducted prior to the beginning of the study with the headmasters, teachers, parents or guardians and their children of the desired age group to explain the purpose of the study and their participation. Consent letters attached with questionnaires were distributed among the class teachers and parents/ guardians involved. Total numbers of 261 students were then randomly chosen from them who agreed to participate in the study.

Data collection tools

A self-administered validated questionnaire was used to gather information. The questionnaire was constructed in English and translated to Malay language and after validation, it was modified to fit the population. The questionnaire had five sections: Socio-demographic data (10 items), Knowledge (10 items), attitude (6 items) and practice (13 items) towards iron deficiency anaemia and Food Frequency Questionnaires (79 items). A face-to-face interview was held for parents/ guardian who had issues with the self-administered questionnaires.

The blood sample was subjected for haemoglobin (Hb) level and determination of iron profile which include serum ferritin, serum iron, and serum TIBC. Stool samples were collected from children identified with anaemia for soil-transmitted helminths analysis.

Haemoglobin concentrations were measured using the haemoglobin meter (HemoCue201+). Children with Hb levels lower than 11.5 g/dl were considered anaemic. (1) In this study haemoglobin levels of 11.0 g/dl to 11.4 g/dl were considered as mild anaemia, 8.0 g/dl to 10.9 were considered as moderate anaemia and lower than 8.0 g/dl were considered as severe anaemia (21). Another 5ml of venous blood were taken for full blood cell test and serum iron assessment. These tests were conducted to support a diagnosis of anaemia due to iron deficiency. Serum iron status was determined by measuring serum iron (SI) levels, serum ferritin (SF) and total iron binding capacity (TIBC). Individuals were diagnosed to have IDA when categorized as iron deficient when either SI or SF level falls below the cut off value. For IDA, an individual should be both anaemic and iron deficient.

Iron profile determining IDA consisted of haemoglobin level less than 11.5 g/dl, serum iron less than 7.1 µg/l, serum ferritin less than<30 ng/l and total iron-binding capacity more than 13.1 µmol/l (14, 22, 23).

A wide mouth and screw caped stool container with an attached scoop were labelled and distributed to the participants who were anaemic to collect stool. Participants were briefed and instructed to scoop a small amount of faeces in the size of thumb using provided scoop into the container and was collected on the following day. The stool samples were analysed within 24 hours after collection. In cases of the stool could not

be analysed immediately, the stool was refrigerated and was kept at -4°c temperature. The stool was analysed using direct smear stool techniques to detect the presence of helminths egg.

Data analysis

Statistical analysis of the data was performed using Statistically Package for Social Science (SPSS) version 24.0. The distribution of quantitative variables was examined for normality using the Kolmogorov-Smirnov Z-test before analysis. Chi-square and Spearman rho correlation test were used to identify the relationship of risk factor variables, demographic factors, socio-economic factors, STH exposure, iron nutritional status and level of knowledge, attitude and practice.

Ethics consideration

The study protocol was approved by the Medical Ethics Committee of University Malaysia Sabah [Research Ethical Code: JKetika 2/17(9)]. After approval by the Ministry of Education (MoE) and Kudat District Education Office, permission was asked from the Principals of each school. And prior to sample collection, informed consent was obtained from the parents or guardians of the students.

RESULTS

The study involved 261 rural schoolchildren age ranged from 8 to 10 years old and they were evenly distributed in three different age groups (Table. 1). In this study, the response rate was 87%. Among these schoolchildren, there were more boys (139 boys) than the girls (122 girls). Table I shows that the majority of them (56%) belonged to Rungus ethnicity, followed by Bajau and Kadazan-Dusun. The majority (56%) of them came from the family with 4-6 members. Many (50%) of their parents were educated up to secondary level (50%), the majority (60%) of their parents were either jobless or farmers with mostly (52%) household income below RM 500.

Out of 261 participants, 82 were found to be anaemic and on based on their haemoglobin concentration majority (59%) were having moderate anaemia and the rest (41%) were having mild anaemia but there was none having severe anaemia. Out of 82 participants, 36 were suffering from IDA accounting for the prevalence of 13.8 % (out of 261) (Table II). The microscopic examination of the stool to investigate the presence of egg of the soil-transmitted helminths were positive for very few (5.4%) of the participants (Table II).

Among the 261 participants, the majority (51%) had a moderate level of knowledge regarding IDA, most (72%) of them were very much positive in their attitude towards it but in case of practice, most (71%) achieved a low level (Table III). The BMI status, the presence of soil-transmitted helminths and level of knowledge regarding IDA had highly significant (p<0.001) association with prevalence of IDA whereas household income, daily iron consumption and level of practice of sanitation had significant (p<0.05) associated with iron deficiency anaemia (Table IV).

Table I: General characteristics of the subjects

Variable	Sub group	Frequency (n)	Percentage (%)
Age of students	8 years old	80	30.7
	9 years old	87	33.3
	10 years old	94	36.0
Gender	Male	139	53.3
	Female	122	46.7
Ethnicity	Bajau	57	21.8
	Kadazan-Dusun	21	8.1
	Rungus	146	55.9
	Irannun	18	6.9
	Kegayan	5	1.9
	Suluk	3	1.1
	Binadan	3	1.1
	Others	8	3.2
Household members	1-3 people	20	7.7
	4-6 people	146	55.9
	7-9 people	86	33.0
	10 people and above	9	3.4
Level of education of parents / guardians	non-formal education / never been to school	18	6.9
	primary school	91	34.9
	secondary school	130	49.8
	college / university	22	8.4
Employment status of parents / guardians	housewife / not working	89	34.1
	farmers	69	26.4
	fisherman	40	15.3
	labour work	15	5.7
	government staff	30	11.5
	self-employed	9	3.4
	others	9	3.4
Household income	Below rm500	136	52.1
	RM501 - RM1000	83	31.8
	RM1001 - RM2000	17	6.5
	RM2001 - RM3000	14	5.4
	RM3001 and above	11	4.2
	Total	**261**	**100**

DISCUSSION

The present study demonstrated that the prevalence of anaemia was 31.4% and the prevalence of IDA was

Table II: Prevalence of anemia, IDA and soil transmitted helminth infestation (n=261)

Variable	Status	Sample (n)	Severity of Anaemia	
			Moderate [a]	Mild [a]
Anemia	**Present**	82 (31.4%)	48 (58.5%)	34 (41.5%)
	Absent	179 (68.6%)		
Iron Deficiency anemia	**Present**	36 (13.8%)*		
	Absent	225 (86.2%)		
Presence of soil transmitted helminths in the stool	**Yes**	14 (5.4%)		
	No	247 (94.6%)		
Total		**261 (100%)**		

36 out of 82 [a] WHO criterion

Table III: Prevalence of IDA in respect of levels of knowledge, attitude and practice (n=261)

		IDA		Total
		Yes	No	
Level of knowledge	**Low**	24 (66.7%)	59 (26.2%)	83 (31.8%)
	Moderate	11 (30.6%)	122 (54.2%)	133 (51.0%)
	High	1 (2.8%)	44 (19.6%)	45 (17.2%)
Level of attitude	**Low**	0 (0%)	6 (2.7%)	6 (2.3%)
	Moderate	15 (41.7%)	51 (22.7%)	66 (25.3%)
	High	21 (58.3%)	168 (74.7%)	189 (72.4%)
Level of practice	**Low**	31 (86.1%)	155 (68.9%)	186 (71.3%)
	Moderate	4 (11.1%)	60 (26.7%)	64 (24.5%)
	High	1(2.8%)	10(4.4%)	11(4.2%)
Total		36 100.0%	225 100.0%	261 100.0%

13.8% which is nearly half (44.6%) of the anaemia prevalence. The results are consistent with (1) statement reported half of the anaemia cases are due to iron deficiency.

Comparing to several local studies on children in Malaysia from the year 2008 to 2017, the prevalence in this study was lower compared to the earliest studies by Al-Mekhlafi et al., (14) and Ngui et al., (9). In Al-Mekhlafi et al., (14) research on 241 aboriginal school children conducted in Pos Betau, Pahang, it has been reported that the prevalence of IDA was 34.0%. In a similar study on 550 children aged 7 to 12 years old by Ngui et al., (9), the prevalence of IDA was 16.9%. However, in contrast, a recent study on the prevalence of IDA on primary school children in Kelantan was found a slightly lower prevalence with 7.7% compared to the result of the present study (24). The difference between these two studies may occur due to the difference of demographic, socio-economic and nutritional factors among the target population. Overall, from the data provided, we can see that there has been a marked decline from a moderate level to a mild level of the prevalence of IDA from the year 2008 to 2018.

In global studies, about 20% - 50% of anaemia cases have been reported and half of the cases are due to

Table IV: Relationship with iron deficiency anaemia with risk factors (n=261)

		Chi-square value with degree of freedom	Spearman's rho	p-value
IDA	**Age**		-0.014	0.822
	Gender	3.463 (1)		0.073
	Ethnicity		-0.112	0.070
	Level of education of parents / guardians	3.267 (1)		0.052
	Household members		-0.053	0.394
	Employment status		0.050	0.426
	Household income		0.140*	0.023
	BMI status		0.280**	<0.001
	Daily iron consumption	7.751* (1)		0.008
	Presence of STH#	77.772** (1)		<0.001
	Level of knowledge		0.294**	<0.001
	Level of attitude		0.117	.059
	Level of practice		0.128*	.038

 # Soil-transmitted helminthes
*** Significant at p<0.05 level**
**** Significant at p<001 level**

the iron deficiency (1). In developing countries, the prevalence of anaemia 5 to 12 years old was estimated to be 46%. In Stoltzfus (3) study on the prevalence of IDA, it has been reported that children in South Asia have the highest rate with 50% and African children with 49%. The global trend of IDA can be seen from the year 2003, 32.4% of IDA has been reported (10) and 19.7% of IDA cases have been reported in Brazil (25). Overall, it can be observed that the same trending of the prevalence of IDA can be seen globally and locally in Malaysia. A positive decline can be seen from both global prevalence and prevalence in Malaysia.

The primary school children were selected because it is regarded as being the most vulnerable groups to iron deficiency and anaemia (1, 3). Previous researches suggested that the risk of anaemia appears early in childhood for both genders, male and female. However, as they grow older, the risk subsides in male but remains higher in females (26, 27). The results are supported by Rushton, Dover (28) study, as they stated in pre-pubertal humans, there was no major difference in

respect of gender in haemoglobin and serum ferritin concentration. The difference starts to emerge after the onset of menstruation. As this present study only involves children from 8 to 10 years old and none of our subjects had menarche, there are no significant differences were found for both gender and age in the association with IDA between male and female.

The population of 261 children in this study was composed of multi-ethnic groups. There has been a significant difference with a p-value of less than 0.001 to reflect that there is an association between ethnicity and IDA. In a study by Park, Kersey (29), some Asian cases may be due to the high prevalence of thalassemia in Asian children (30). However, in this present study, a further specific investigation is needed in order to confirm the relationship of thalassemia and IDA. There is no clinical diagnosis to screen for thalassemia cases in this present study, the screening for thalassemia in children depending based on parents or guardians' answers verbally.

The results in this present study have demonstrated that there has been a marked sign association between household members with IDA as the finding shown the result of p-value less than 0.001. As the number of family size in the house increase, their standard of living affected thus their expenditure will increase and share of food in expenditure will decrease that leads to food insecurity (11). There is evidence have shown that large family size was associated with a higher risk of low iron levels thus increase in the prevalence of IDA (10, 13). Significant association of P-value less than 0.001 between the employment status or type of occupation and IDA was noted in this present study which similar to the findings by Ngui, Lim (9) in their study of the association between IDA and socio-economic factors in Malaysia. The types of occupation or employment status may affect the household income of the family. The prevalence of IDA is higher among children living at or below the poverty level than those above the poverty level. It has been suggested that children from the low-income family had a higher tendency to have iron deficiency compared to the children from the high-income family. This may be due to the food insecurity that is caused by the low household income and in some cases have a large family size. Therefore, there has been limited food availability among children. This statement is supported by the previous study that reported about poor dietary intakes contribute to IDA in children from low-income family (31).

The study on the risk factor of educational level among parents and guardians leads to another risk factor in the study which is the level of knowledge, attitude, and practice (KAP) towards IDA. Moreover, it is important to assess the level of KAP among parents and guardian especially among mothers as they are responsible in terms of cooking and preparing foods thus affecting the iron status intake in their daily nutrients. The result of P-value <0.001 is obtained in the study showing that there is a marked significant between the levels of KAP with IDA. In a previous study comparing rural and urban communities on the levels of KAP towards IDA, it has been reflected that the knowledge level of urban communities towards IDA was better than rural communities (32). In addition, unacceptable attitude and practices, especially in nutrition and sanitation and hygienic practice towards children, can cause severe nutritional problems such as IDA. In other studies of KAP level regarding sanitation and hygienic practices, it has been suggested that inadequate KAP level may lead to STH infections (33).

Our findings have shown that there is a significant difference between soil-transmitted helminths infestation with IDA with the p-value of less than 0.001. Several similar studies have been conducted globally to investigate the relationship between STH infestation and IDA. It has been often reported that STH infestation occurred as a result of poor hygienic and sanitation practices (14). From other studies, it has been highlighted that STH infestation is a significant cause of IDA and anaemia among children.

Other than low socio-economic and STH infestation, poor dietary intake in nutritional status of the children plays an important role as a contributor to IDA. The interaction between food high in phytates, polyphenol and other inhibitors may decrease the bioavailability of iron (34). Despite concentrating on the bioavailability of iron absorption in the body, availability of high iron source food should be taken into consideration. In some developing countries, access to these foods among the rural population is still limited due to the distance and low socio-economic. Therefore, iron-fortified food/snacks, complementary foods and infants' formula which contributes to the aid of IDA and one of the excellent methods to increase consumption of iron was hardly obtained in rural areas of Kudat, Sabah. Dietary habits or patterns lacking diversity, decrease consumption of haem-iron foods and lacks iron-fortified foods are directly associated with IDA (35). The finding of this study has shown a p-value of 0.007 which reflected that there is a significant difference between iron consumption of the children with IDA. In this present study, due to the low socio-economic status such as low household income, it can be seen that most of the family have a limited source of iron-source food. Moreover, low intake of haem-iron food such as meat and vegetables that high in iron together with high intake of dairy products created interaction with inhibitors which decrease iron absorption in the body (16).

In Malaysia, about 90% of "Sekolah Kekurangan Murid (SKM)" has been reported with low standards state, limited budgets and poor facilities as well as highly trained teachers (36). Hence, there have been difficulties

in collecting samples especially blood and stool samples as the school session only run until afternoon. Besides that, there have been difficulties in gaining cooperation from young children during collecting samples (blood and stools) due to the fear of pain. For clinical lab result that suspected with thalassemia, we have suggested the parents do a further medical investigation on confirming thalassemia cases. Ethnicity, level of education of parents or guardians, types of occupation, household income, household members, body mass index status, level of knowledge, attitude and practice, the presence of soil-transmitted helminths, and limited intake of iron were found to be associated significantly with the prevalence of iron deficiency anaemia. Findings of this study exposed that more attention in rural development, especially in community health, education and infrastructure, are needed.

CONCLUSION

Thus, during the study period, the prevalence of IDA among 8 to 10 years old school children from rural areas in Kudat was 13.8%. Furthermore, by improving the household economy, education, sanitation, and personal hygiene status and promoting consistent nutritional education among the population may help to reduce the prevalence of IDA.

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