 doi:10.20944/preprints202210.0278.v1

Association between Knowledge about Anemia, Food Consumption Behaviors, and Hematocrit Level among School-Age Children in Nakhon Si Thammarat Province, Thailand

Pastraporn Kaewpawong[1] Kiatkamjorn Kusol[1] Onuma Bunkarn[2] Sirikran Sutthisompohn[1]

[1] School of Nursing, and the Excellence Center of Community Health Promotion, Walailak University, Nakhon Si Thammarat, Thailand
[2] Saikhueng Sub-District Health Promoting Hospital, Suratthani, Thailand
* Correspondence: Kiatkamjorn Kusol[1], School of Nursing, and the Excellence Center of Community Health Promotion, Walailak University, 222 Thaiburi, Thasala District, Nakhon Si Thammarat 80161, Thailand. Tel +66 081-9796565; kkiatgum@gmail.com

Abstract: Anemia is a significant public health problem among children, especially school-age children because their body quickly produces red blood cells to provide sufficient blood volume with plasma expansion to maintain blood concentration. This research aimed to study the anemia situation, knowledge about anemia, food consumption behaviors, and the association between knowledge, food consumption behaviors, and hematocrit level among school-age children in primary school, in Thasala district, Nakhon Si Thammarat Province. This is a descriptive study among 408 students, Grades 4 to 6, aged 9-12 years. Research instruments included the demographic data of the children and their knowledge about anemia, food consumption behaviors, and hematocrit assessment. Data were analyzed using descriptive, Spearman's rank correlation coefficient, and logistic regression statistics. The results revealed that 23.2% of the samples had anemia, whereas 22.22% had mild anemia and 0.98% had moderate anemia. The children knew about anemia, where the mean score was at a moderate level (Mean= 6.63; SD= 2.51) out of 10. The mean score on food consumption behaviors was in the moderate level (Mean= 17.49; SD= 3.68) out of 24. There were significantly positive correlations between the knowledge about anemia and the hematocrit level at a moderate level ($r= 0.45$, $p< 0.001$). Correlation analysis revealed moderate food consumption behaviors with the hematocrit level ($r= 0.40$, $p< 0.001$). When confirm with Logistic regression found that knowledge about anemia (OR = 9.15, 95% CI: 4.57-18.34), and food consumption behaviors (OR = 19.09, 95% CI: 9.71-37.53) were significantly associated with the hematocrit level. Conclusions: This study showed that knowledge and appropriate food consumption behaviors are associated with hematocrit levels. Enhancing knowledge about anemia and food consumption behaviors may be reduced the prevalence of anemia in school-age children. The health care providers in primary care should be encouraged children to have health education and eat sufficient food.

Keywords: knowledge; food consumption behaviors; hematocrit level; school-age children

1. Introduction

Anemia in children is a significant public health problem worldwide in developing and developed countries. However, the prevalence is exceptionally high in developing countries. A World Health Organization (WHO) survey found that 30 percent or more than 1.3 billion people were anemic [1]. Approximately 500-600 million people, or one-third of the world's population, are affected by anemia and develop iron deficiency anemia but may be asymptomatic because the body still has iron stored in reserve [2,3]. Still, chronic anemia, especially in children, is one of the causes of illness and risk of death because it inflicts low immunity and higher susceptibility to infection than in adults [4]. In Latin America and the Caribbean, the prevalence of anemia among school-age children was 17.49 % [5]. A study in Southwestern Ethiopia found that 37.6% of school-age children

 doi:10.20944/preprints202210.0278.v1

had anemia, while 18.1% had mild anemia, and 19.5% had moderate anemia [6]. In Thailand, the prevalence of anemia in school-age children was 27% based on the WHO-prescribed red blood cell concentration criteria (Hb < 12 g/dL and Hct < 36%).[1] In particular, a survey by the Division of Nutrition, Department of Health found that the prevalence of anemia among 6-year-old children was 31.1%. This was greater than the acceptable limit based on the Thailand Department of Health criteria at 10% of anemia [7].

Anemia causes a decrease in growth, cognitive processes, intelligence, and learning efficiency among school-age children. Anemia is one of the top 5 causes taking a grip on the health of Thai children aged 0-14 years. A study on the impact of chronic anemia among school-age children found that children exhibited slower physical growth, stunting at the growth thresholds, and developmental delays compared to others of the same age group [8,9]. Additionally, it affects the immune mechanism causing a reduction of pathogens, physical activity, and infection, making children constantly sick [10]. There is also a manifestation of symptoms including tiredness, fatigue, decreased ability to exercise, and decreased capacity to learn [11]. Long-term effects can adversely lead to neurodevelopmental disorders [12]. In addition, emotional and behavioral effects among children included being easily irritable, fearful, and startled; and a lack of confidence, and motivation [13].

The factor causing school-age children to suffer from anemia includes a decrease in red blood cell production [14]. In developing countries, food consumption behaviors contribute to the insufficiency of meeting the body's needs among growing school-age children. In addition, food consumption behaviors include avoiding diets containing green leafy vegetables or meat and habitual consumption of crispy snacks and soft drinks. Other factors include tooth decay, chronic blood loss from hookworm infections, lice, and stomach ulcers. Anemia is more common among mothers and low-income families, and those with lower parental education levels are more susceptible than those with higher incomes and education [6,11,15,16].

Control and prevention of anemia rely on both medication and non-medication formulations. School-age children, 6-14 years, should eat 60 mg of iron tablets once a week [17]. The Department of Health, Ministry of Public Health has issued a policy for the school health section to focus on nutrition education and screening for anemia. However, it is still impossible to cover all areas due to a lack of budget and clarity in implementing the policy. As a result, screening and prevention of anemia in school-age children are not comprehensive in many areas [18,19]. In addition, school-age children are paler than the standard set by the Department of Health, Thailand. There were studies among preschool children on the effectiveness of nutrition promotion programs on the growth of preschool children in child development centers. As a result of implementing the program, preschool children grew better. Their asymmetry passed higher standards. Parents and teachers increased nutrition promotion attitudes and practices [20]. For a group of high school students, the effect of nutrition promotion programs on nutritional behaviors and red blood cell concentrations led to improved food consumption behavior and increased blood concentrations in adolescents [21,22]. For school-age children, there was a study on the dietary behaviors of a modification program among children with overnutrition, which found that the children understood food consumption and improved in their food consumption behaviors [23,24].

Furthermore, a study on knowledge and food consumption behaviors among the Phasi Charoen people found that most consumer behaviors had a moderate level of expertise. The most common food consumption behavior among school-age children was drinking sweetened milk. The media has a considerable influence on the food consumption behaviors of children. Children suffering from overweight conditions and obesity had inappropriate food intake as school-age children [25].

Because there are relatively few studies on anemia among school-age children, most studies focus on early childhood and adolescence. An important issue is knowledge and food consumption behaviors that can protect against anemia in children [26]. According

 doi:10.20944/preprints202210.0278.v1

to commercial media, food consumption shows that school-age children still lack an understanding of food consumption behaviors, although school-age children can learn many things in terms of their health and the environment around them. In this study, the hematocrit test for assessing anemia and assessing knowledge and food consumption behaviors was investigated. The researchers noticed the necessary information about the anemia situation among school-aged children. The researchers hope that this study can reflect the anemia situation, knowledge, and food consumption behaviors of school-age children and their hematocrit levels. This research aimed to study the anemia situation, knowledge about anemia, food consumption behaviors, and the association between knowledge, food consumption behaviors, and hematocrit level among school-age children in primary school in the Thasala district**.** The outcome of this study will help teachers and primary health care can design and take action through health education programs for students following the policy of public health to decrease anemia in the criteria of not more than 10%.

2. Materials and Methods

2.1. Study design

This study was a cross-sectional descriptive research. The research population included school-age students in Grades 4 to 6, aged 9 to 12 years, in Nakhon Si Thammarat Province. The researchers randomized and assigned to the Thasala district. The Thasala district's children population totals 3,691 studying in primary schools located in the Thasala district. The researchers calculated the sample size using the Krejcie and Morgan formula and added about 15 % to prevent the collection of incomprehensive data, and generate 408 research samples.

2.2. Measures

Recruitment and sampling: Stratified sampling was randomly selected, followed by a random sample of schools from 10 subdistricts. Simple random selection was used to determine the 5 schools to be studied in selected 3 subdistricts to meet the predetermined size of a sample group and represent each community, followed by simple random sampling in compliance with the inclusion criteria, yielding a group of 408 research samples. The sample was school-age children in grade 4= 145, grade 5= 139, and grade 6= 124 persons.

The inclusion criteria included no congenital diseases, no blood diseases, no experience of operations or blood transfusion, and no accidents inflicting blood loss over the past three months. Furthermore, in girls who do have not the menstrual phase, participants also need to be able to read, write and verbally communicate. Both children and parents consented to participate in the study, which preceded the process entailing the documentation of the children's history, the hematocrit test, the assessment of their knowledge about anemia and its prevention, and their food consumption behaviors.

2.3. Research Instruments

1. Demographic Data Questionnaire: This was employed to collect demographic data comprising sex, age, weight, height, educational levels, number of siblings for school-age children, religion, family roles, and occupations of the caregivers.

2. Assessment of anemia: The result of the hematocrit level from a packed red cell volume (PCV) was assessed as normal when Hct ≥36 %, and anemic when Hct< 36 % (mild = 30-35%, moderate = 21-29%, severe = <21%) [6,7].

3. Knowledge Assessment of Anemia and its Prevention: The researchers adapted the original knowledge assessment version by Chanjira Saengngern which had a score of reliability 0.89 for precision and consisted of 10 items (each of which was to be answered Yes or No) yielding a total score of 10 points [27]. The scores can be divided into three levels. One correct answer generated one point, while an incorrect answer was zero points.

 doi:10.20944/preprints202210.0278.v1

Consequently, scores lower than 60% (< 6 points) demonstrated a low level of knowledge, 60 to 79% (6-7.9 points) showed a moderate level, and 80% or higher (8-10 points) indicated a good level of knowledge [28].

4. Assessment of Food Consumption Behaviors in Children: The researchers adapted the assessment from the Department of Health, Bureau of Nutrition, Ministry of Public Health, consisting of 6 items yielding a total score of 24 points, using a 4-point rating detailed as follows [18].

Always engage in that behavior, averaging 5 to 7 times or 5 to 7 days a week	= 4
Occasionally engage in that behavior, averaging 3 to 4 times or 3 to 4 days a week	= 3
Rarely engage in that behavior, averaging 1 to 2 times or 1 to 2 days a week	= 2
No engagement in that behavior, in one week	= 1

The 24 points were divided into three levels detailed as follows:

Score 18-24	=	Good
Score 12-17	=	Moderate
Score 6-11	=	Low

For the reliability measurement, the assessment of the knowledge about anemia and food consumption behaviors was later distributed to 30 school-age children sharing the same characteristics as the research samples. The yielded score for reliability was 0.77 and 0.73, respectively.

2.4. Ethical considerations

The researchers conducted the study following the Declaration of Helsinki. All procedures performed in this study involving human participants followed the ethical standards of the Ethical Institution*al* Consideration. This study received approval from the Ethics Committee on Human Research at Walailak University on April 30, 2020. (WUEC-20-092-01) as required by the process before data collection. Inform consent was obtained by the researchers from all individual participants included in the study.

2.5. Statistical Analysis

This study analyzed the statistics using the SPSS software (Version 24) for Windows™ (IBM Corporation, New York, NY, USA). The statistics employed the following:

1. Descriptive statistics were used to analyze the demographic data, anemia situation, knowledge about anemia, and food consumption behaviors entailing frequencies, percentages, means, and standard deviations (S.D.).

2. The association between knowledge, food consumption behaviors, and hematocrit level was analyzed using the Kolmogorov-Smirnov test, demonstrating a difference from a normal distribution. The association was analyzed using Spearman's rank correlation coefficient, and using binary logistic regression statistics, determining statistical significance at 0.05.

3. Results

The results of the descriptive research to study the demographic data, a situation of anemia, knowledge about anemia, and food consumption behaviors; and the association between knowledge about anemia, food consumption behaviors, and hematocrit level in school-age children are as follows:

The demographic data of the school-age children Grade 4-6 indicated that 53.9 percent of the children were females and 46.1 percent were males. Sixty percent were aged 11-12 years, followed by 9-10 years accounting for forty percent. For religion, 56.4 percent were Muslim, followed by Buddhists accounting for 43.6 percent. The height index for age and weight index for age reveals that the school-age children have achieved the age-appropriate standard of 70.3%, and 69.4%, respectively. Caregivers included parents, accounting for 53.2 percent, followed by grandparents at 19.4 percent. Regarding occupations of the caregivers, 45.6 percent were wage earners, followed by trades at 20.1 percent.

 doi:10.20944/preprints202210.0278.v1

Finally, 30.4 percent of the children had more than three siblings, followed by 27.6 percent having two siblings.

The 408 school-age children demonstrated a hematocrit level range = 25-47 %, Mean = 37.66 %, and SD =3.35, with 76.8 percent not having anemia (normal) and 23.2 percent have anemia. Those experiencing anemia had a hematocrit (Hct) value falling in the range of 25- 35 %, with a mean Hct of 33.07 %. Based on the anemia condition levels, a total of 95 school-age children had anemia, 91 (22.22 %) of whom had a mild level of anemia, and 4 (0.98 %) of whom had a moderate level, as shown in (Table 1).

Table 1. Number and percentage of the samples with Hematocrit level, normal, and anemia (n = 408).

Hematocrit level	**Normal** n(%)	**Anemia** n(%)	**Total** n(%)
School-age Grade 4	100 (24.6)	45 (11.0)	145 (35.6)
School-age Grade 5	107 (26.2)	32 (7.8)	139 (34.0)
School-age Grade 6	106 (26.0)	18 (4.4)	124 (30.4)
Overall	313 (76.8)	95 (23.2)	408 (100)
Hct (Range=25-47, Mean=37.66, S.D.= 3.35)		Hct (Range=25-35, Mean=33.07, S.D.= 2.74) Mild = 91 (22.22 %) Moderate = 4 (.98 %)	

The mean score of the knowledge assessment about anemia in school-age children was 6.63 (SD = 2.51) out of 10, indicating a moderate level. The mean score of the food consumption behaviors of the school-age children was 17.49 (SD = 3.68) out of 24, showing a moderate level, as demonstrated in (Table 2).

Table 2. Mean score and standard deviation (SD) of the knowledge about anemia and food consumption behaviors of the samples (n = 408).

Variable	**Min**	**Max**	**Mean**	**S.D.**	**Level**
Knowledge about anemia	1	10	6.63	2.51	Moderate
Food consumption behaviors	8	24	17.49	3.68	Moderate

The relationship between the knowledge about anemia, food consumption behaviors, and anemia prevention was assessed using Spearman's rank correlation coefficient statistics. This study found that knowledge about anemia and food consumption behaviors were associated with hematocrit levels at 0.45 and 0.40 ($p < 0.001$), respectively, at a moderate level, as shown in (Table 3).

 doi:10.20944/preprints202210.0278.v1

Table 3. Relationship between knowledge about anemia, food consumption behaviors, and hematocrit level of the samples (n = 408)

Variable	r	*p*-value	Level
Knowledge about anemia	0.45	0.001***	Moderate
Food consumption behaviors	0.40	0.001***	Moderate

***p < 0.001

Furthermore, using binary logistic regression analysis suggested that the children with knowledge of more than 6 scores in moderate to a good level were significantly associated with a hematocrit level (OR = 9.15 (95% CI: 4.57-18.37). In terms of Food consumption behaviors, the children exhibited a good level associated with a hematocrit level significantly (OR = 19.09; 95% CI: 9.71-37.53), as displayed in Table 4.

Table 4 Binary logistic regression analysis for exploring knowledge and food consumption behaviors factors associated with Hematocrit level (n = 408)

Variable		**Hematocrit level**								
		Normal N (%)	**Anemia N (%)**	**B**	**SE**	**Wald**	**df**	**Sig**	**EXP(B)**	**95% CI**
Knowledge of anemia	Score < 6	95 (54)	81 (46)						1	1
	Score > 6	218(94)	14 (6)	2.21	.36	38.95	1	.00**	9.15	4.57-18.37
Food consumption behaviors	Score < 18	58 (41.7)	81 (58.3)						1	1
	Score > 18	255(94.8)	14(5.2)	2.95	.35	73.06	1	.00**	19.09	9.71-37.53

Cox & Snell R Square = .37, Nagelkerke R Square = .56

4. Discussion

The study results regarding the anemia situation, knowledge about anemia, food consumption behaviors, and hematocrit level among school-age children in the Thasala district, Nakhon Si Thammarat suggested that 23.2 percent had anemia, most of whom had a mild level. The knowledge assessment about anemia and food consumption behaviors for anemia prevention demonstrated that the target group was at a moderate level for both topics. Furthermore, the study results showed that knowledge about anemia and appropriate food consumption behaviors were associated with a hematocrit level in school-age children.

The prevalence of anemia among primary school children in Nakhon Si Thammarat was 23.2 percent, indicating a mild to moderate level. Nevertheless, without proper screening, children would not be aware of the anemia condition since no apparent symptoms manifested due to the mild to average levels of anemia resulting from the body's iron stored in reserve.[1] The prevalence of anemia among school-age children revealed in this study seemed to be higher than the prevalence investigated in the conditions among Asian adolescents in Indonesia, the Republic of China, and Kuwait, where the anemia

 doi:10.20944/preprints202210.0278.v1

prevalence was at 14, 12, and 8.06 percent, respectively [29-31]. However, it was lower than that found in low-income countries such as Ethiopia, Ghana, and Nepal, where the anemia prevalence was 37.3, 29.4, and 31 percent, respectively [32-34]. Anemia is still a common problem in developing countries. Social, cultural, and economic disparity is undeniably associated with accessibility to iron-rich foods and public health systems. Compared to a national level, it was found that Thailand's school-age children's anemia condition has exceeded the acceptable level as determined by the Department of Health, which should not exceed 10 percent. This indicated that anemia among the target group of this study was two times higher than the standard set [35]. Currently, anemia still exists in developing countries and needs to be addressed with a collaborative effort from multiple parties including schools, families, children themselves, and health professionals. Treatment for this condition has to be non-medication-reliant. According to the Bureau of Nutrition's policy, iron and folic acid supplements should be incorporated once a week [35].

Regarding knowledge about anemia and food consumption behaviors for anemia prevention, the sample group exhibited knowledge about anemia and food consumption behaviors at a moderate level. It was noticeable that the mean scores on knowledge about anemia increased at higher education levels. This indicated that school-age children with higher academic grades and those who were older had better abilities to learn, access information, plan, and seek solutions to self-care by themselves [36]. A majority of the sample group seemed to lack knowledge about foods and beverages inhibiting the absorption of iron and those enhancing it. This result is consistent with researchers who proposed that among young Ghanaian adolescents aged 10 to 14 years, 18.2 percent knew about iron enhancers while 0.7% knew about iron inhibitors [33]. This harmonizes with the study by Chiangkhuntod et al., who studied the knowledge and food consumption behaviors of the residents of Phasi Charoen, Bangkok, and reported that most knew about anemia and food consumption behaviors at a moderate level [25]. For school-age children, the most frequent foods consumed were sweetened milk and commercial foods. The study by Phuengphai et al. demonstrated that children aware of their capability could predict their nutritional health behavior [37]. This indicates that if school-age children clearly understand the benefits of food consumption, appropriate food consumption behavior should follow.

The relationship between knowledge about anemia, food consumption behaviors, and hematocrit level in the sample was at a significantly moderate level. This result is consistent with the study on the associated factors among school-age children in Gondar Town public primary schools, Northwest Ethiopia, which proposed that anemia among school-age children residing was associated with the insufficient intake of iron-rich foods [38]. Likewise, there is also consistency in the food consumption behaviors among young adolescents who are knowledgeable about anemia conditions due to iron deficiency; they tend to orient themselves toward consuming foods rich in protein and iron to address the cause and symptoms of anemia. The study also suggested that the correlation between knowledge and food consumption behaviors is negative with anemia, leading to an increase in the capacity for anemia prevention.[33] Emphasizing the significance of knowledge about anemia and food consumption behaviors among school-age children can be increased hematocrit levels. In children with sufficient understanding and commitment to proper food consumption behaviors, anemia can be decreased, which is consistent with the suggestions by Abu-baker et al., and Gebreyesus et al [39-40]. Therefore, there is a pivotal need to promote understanding and practice among school-age children to establish appropriate food consumption behaviors that can effectively higher the hematocrit percentages of children and decrease suffering from anemia. Recent studies recommended iron supplementation and appropriate nutrition management as the health policy was the one method to treat anemia for a school-aged child in a developing country.

 doi:10.20944/preprints202210.0278.v1

5. Conclusion

Anemia remains a persistent public health issue among school-age children. This study found sufficient knowledge and appropriate food consumption behavior in school-age children at a significantly average level associated with their hematocrit level. Most of them seemed to have knowledge and food consumption behaviors at a moderate level. As a result, children should have adequate knowledge of this issue and develop food consumption behaviors that can decrease long-term suffering from anemia.

Acknowledgments: The authors wish to thank the Research Institute for Health Sciences and the Excellence Center of Nursing Institute, Walailak University, for providing invaluable support. We want to express our gratitude to school directors, teachers, parents, and target group participants.

Conflict of interest: The authors have no conflict of interest.

Funding: The authors disclosed receipt of the financial support for the research authorship by the Research Institute for Health Science, Walailak University, Nakhon Si Thammarat, Thailand, with Grant Number WU-IRG-63-012.

Ethics: All procedures performed in studies involving human participants followed the ethical standards of the Ethical Institutional Consideration. The researchers conducted the study following the Declaration of Helsinki. This study received approval from the Ethics Committee on Human Research at Walailak University on April 30, 2020. (WUEC-20-092-01) as required by the process before data collection. Inform consent was obtained by the researchers from all individual participants included in the study.

Data availability statement: Data is available on request from the authors.

Orchid iD: Kiatkamjorn Kusol https://orcid.org/0000-0003-4831-1601

References

1. World Health Organization. The global prevalence of anemia in 2011. Geneva: World Health Organization; **2015**. Available from: https://www.who.int/health-topics/anaemia. Accessed January 26, 2021.
2. Chaparro CM, Suchdev PS. Anemia epidemiology, pathophysiology, and etiology in low- and middle-income countries. *Ann N Y Acad Sci*. **2019**;1450(1):15-31. https://doi.org/10.1111/nyas.14092.
3. Tanthanate C. Iron deficiency anemia; **2011**. Available from: http://www.si.mahidol.ac.th/sidoctor/e-pl/articledetail.asp?id=850. Accessed June 29, 2020. (In Thailand)
4. Jonker FA, Boele van Hensbroek M. Anaemia, iron deficiency and susceptibility to infections. *J Infect*. **2014**; 69 Suppl 1:S23-7. https://doi.org/10.1016/j.jinf.2014.08.007.
5. Iglesias Vázquez L, Valera E, Villalobos M, Tous M, Arija V. Prevalence of Anemia in Children from Latin America and the Caribbean and Effectiveness of Nutritional Interventions: Systematic Review and Meta-Analysis. *Nutrients.* **2019**; 11(1):183. https://doi.org/10.3390/nu11010183
6. Assefa S, Mossie A, Hamsa L. Prevalence and severity of anemia among school children in Jimma Town, Southwest Ethiopia. *BMC Hematology.* **2014**;14(3):1-9. https://doi.org/10.1186/2052-1839-14-3

7. Department of Health, Ministry of Public Health. Guidelines for iron supplementation for Thai people. Nonthaburi: Ministry of Public Health; **2014**. Available from: https://nutrition.anamai.moph.go.th/main.php?filename=anemia. Accessed November 3, 2020. (In Thailand)
8. El Kishawi RR, Soo KL, Abed YA, Wan Muda WA. Anemia among children aged 2-5 years in the Gaza Strip- Palestinian: a cross-sectional study. *BMC Public Health*. **2015**;15:319. https://doi.org/10.1186/s12889-015-1652-2
9. Khan JR, Awan N, Misu F. Determinants of anemia among 6–59 months aged children in Bangladesh: evidence from nationally representative data. *BMC Pediatr*. **2016**;16:3. https://doi.org/10.1186/s12887-015-0536-z
10. Rahmanist S, Demmouche A. Iron deficiency anemia in children and alteration of the immune system. *Journal of Nutrition & Food Sciences*. **2015**; 5: 333. https://doi.org/10.4172/2155-9600.1000333.
11. National Institute of Child Health Development, Department of Health, Ministry of Public Health. *Annual Report 2017 National Institute of Child Health Development*. Bangkok: Sam Charoen Panich Company Limited; **2017**. Available from: http://www.childrenhospital.go.th/html/2014/th/. Accessed June 2, 2020. (In Thailand)
12. Chen MH, Su TP, Chen YS, et al. Association between psychiatric disorders and iron deficiency anemia among children and adolescents: a nationwide population-based study. *BMC Psychiatry.* **2013**;13:161. https://doi.org/10.1186/1471-244X-13-161.
13. Fuglestad P, Rothman A, Jeffery R. The Effects of Regulatory Focus on Responding to and Avoiding Slips in a Longitudinal Study of Smoking Cessation. *Basic Appl Soc Psych*. **2013**;35(5):426-435. https://doi.org/10.1080/01973533.2013.823619.
14. Wiprakasit W. Approach to Childhood Anemia. *Journal of Hematology and Transfusion Medicine.* **2014**; 24(4):395-405. Available from: http://tsh.or.th/Journal/Views/92. Accessed March 10, 2021.
15. Kumar T, Taneja S, Yajnik CS, Bhandari N. Prevalence and predictors of anemia in a population of North Indian children. *Nutrition*. **2014**; 30(5):531-7. https://doi.org/10.1016/j.nut.2013.09.015.
16. Inthawong S. Prevalence and risk factors for anemia and iron deficiency in female junior high school students Vientiane Lao People's Democratic Republic. *Journal of Medical Technology and Physical Therapy.* **2014**; 26(2): 141-149. Available from: https://he01.tci-thaijo.org/index.php/ams. Accessed August 30, 2021
17. Pasricha SR, Drakesmith H, Black J, et al. Control of iron deficiency anemia in low- and middle-income countries. *Blood*. **2013**; 121(14): 2607-17. https://doi.org/10.1182/blood-2012-09-453522.
18. Bureau of Nutrition, Department of Health, Ministry of Public Health. *Handbook of iron supplementation An evaluation of a program promoting access to school health services in the context of local authorities' primary schools*. Nonthaburi: Department of Health, Ministry of Public Health; **2017**. Available from: https://nutrition.anamai.moph.go.th/main.php?filename=anemia. Accessed June 2, 2020. (In Thailand)
19. Dejutamanee R, Mulratana A, Arunakun J, Phoyam W, Empremsilp S. The effectiveness of weekly iron supplementation in preventing anemia from Iron deficiency in junior high school students. *Wachirasarn Nursing*. **2018**; 20(2):13-21. Available from: https://he02.tci-thaijo.org/index.php/vnj/article/view/160438. Accessed August 10, 2020. (In Thailand)

20. Wangrat J, Onduang N, Chanwikai Y, Singhan C, Baitrakul S. The Effectiveness of Nutritional Promotion Program on Growth of Preschool Children in Center Child Development, Pong Yang Kok Subdistrict, Hang Chat District Lampang Province. *Journal of Public Health and Development*. **2018**; 16(2): 1-13. Available from: https://he01.tci-thaijo.org/index.php/AIHD-MU/issue/view/16992. Accessed June 15, 2021. (In Thailand)
21. Jaranai P, Nirattharadon M, Buabun N. Effects of Nutrition Promotion Program on Nutrition Behavior and Red Blood Cell Concentration in Adolescent Pregnant Women. *Journal of Nursing Science Chulalongkorn University*. **2018**;30(1) :59-69. Available from: https://he01.tci-thaijo.org/index.php/CUNS/article/view/120583. Accessed February 12, 2021. (In Thailand)
22. Khunkitti S. *The effect of nutrition promotion program on red blood cell concentration in adolescent pregnant women with anemia*. [Master of Nursing Thesis Department of Family Medicine Nursing Faculty of Nursing], Pathumthani; Thammasat University: **2009**. (In Thailand)
23. Insri P, Chittanoon P, Piriyakunthorn S. The Development of a Health Behavior Modification Operating Manual for School-aged Children with Over Nutrition. *Songklanagarind Journal of Nursing*. **2015**; 35(2): 177-190. Available from: https://he02.tcithaijo.org/index.php/nur-psu/article/view/38685. Accessed November 3, 2020.
24. Jaicherdchu R, Udomwong N, Boonchiang W. Development of a community-based health promotion program for overweight students. *Nursing Journal*. **2013**;40(2):64-76. Available from: https://he02.tci-thaijo.org/index.php/cmunursing/article/view/33058. Accessed February 12, 2021. (In Thailand)
25. Chiangkhunthod S, Matthawangkun C, Chancharoen K, et al. *Research report. Knowledge and food consumption behavior of the tax people in Bangkok*. Nonthaburi: Health Promotion Foundation Health Systems Research Institute; **2014**. (In Thailand)
26. World Health Organization. *Nutritional Anemia: Tools for effective prevention and control*. Geneva: The WHO document production service; **2017**. Available from: https://apps.who.int/iris/bitstream/handle/10665/259425/9789241513067-eng.pdf?sequence=1. Accessed January 26, 2021.
27. Sanghen J. The Guidelines for Diagnosis and Management of Anemia in Primary Education Students at Banlumnow Subdistrict Bangkhan District Nakhon Si Thammarat Province. [Master of Nursing Sciences Program in Community Nurse Practitioner], Nakhon Si Thammarat: Walailuk University; 2009. (In Thailand)
28. Bloom BS. Mastery learning. In JH. Block (Ed.), Mastery learning, theory, and practice. New York: Holt, Rinehart, and Winston; **1971**. 47-63
29. Andriastuti M, Ilmana G, Nawangwulan SA, Kosasih KA. Prevalence of anemia and iron profile among children and adolescents with low socio-economic status. *Int J Pediatr Adolesc Med*. *2020*;7(2):88-92. https://doi.org/10.1016/j.ijpam.2019.11.001.

30. Wang JY, Hu PJ, Luo DM, et al. Reducing Anemia Among School-Aged Children in China by Eliminating the Geographic Disparity and Ameliorating Stunting: Evidence From a National Survey. *Front Pediatr*. **2020**;8:193. https://doi.org/10.3389/fped.2020.00193.
31. Shaban L, Al-Taiar A, Rahman A, et al. Anemia and its associated factors among adolescents in Kuwait. *Sci Rep*. **2020**;10(1):5857. https://doi.org/10.1038/s41598-020-60816-7.
32. Tariku EZ, Abebe GA, Melketsedik ZA, et al. Anemia and its associated factors among school-age children living in different climatic zones of Arba Minch Zuria District, Southern Ethiopia. *BMC Hematology*. **2019**;19:6. https://doi.org/10.1186/s12878-019-0137-4
33. Wiafe MA, Apprey C, Annan RA. Knowledge and practices of dietary iron and anemia among early adolescents in a rural district in Ghana. *Food Sci Nutr*. **2021**;9(6):2915-2924. https://doi.org/10.1002/fsn3.2249.
34. Chalise B, Aryal KK, Mehta RK, et al. Prevalence and correlates of anemia among adolescents in Nepal: Findings from a nationally representative cross-sectional survey. *PLoS One*. **2018**;13(12):e0208878. https://doi.org/10.1371/journal.pone.0208878.
35. Bureau of Nutrition, Department of Health, Ministry of Public Health. *Control Guidelines Approaches to control and prevent iron deficiency anemia*. Nonthaburi: Ministry of Public Health; **2013**. (In Thailand)
36. Piaget J. *The theory of stages in cognitive development*. New York: McGraw Hill; **1973**.
37. Phuengphai U, Sananruangsak S, Teerarangsikul N. Predictive factors predicting health behaviors of school-age children Singburi Province. *Journal of Nursing Science Chulalongkorn University*. **2017**; 29(1): 92-103. Available from: https://he01.tcit-haijo.org/index.php/CUNS/article/view/87583. Accessed August 30, 2021.
38. *Prevalence* of *anemia* and *associated factors among school children* in *Gondar town public primary schools*, *northwest Ethiopia*: A school-based. *PLOS ONE*. **2017**; 12(12): e0190151. https://doi.org/10.1371/journal.pone.0190151.
39. Abu-Baker NN, Eyadat AM, Khamaiseh AM. The impact of nutrition education on knowledge, attitude, and practice regarding iron deficiency anemia among female adolescent students in Jordan. *Heliyon*. **2021**; 7(2): e06348. https://doi.org/10.1016/j.heliyon. 2021.e06348.
40. Gebreyesus SH, Endris BS, Beyene GT, et al. Anemia among adolescent girls in three districts in Ethiopia. *BMC Public Health*. **2019**; 19(92): 1-11. https://doi.org/10.1186/s12889-019-6422-0.