Original article

Prevalence and associated factors of iron deficiency anemia among female medical students

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Abstract:

Objective: *This study aimed to determine the prevalence of iron deficiency anemia (IDA) and associated factors among Thai female medical students.* **Materials and methods:** *A cross-sectional study of healthy Thai female medical students, aged between 20 and 25 years, was conducted between June 2019 and February 2021. Socio-demographic data, dietary habits, menstrual pattern, history of blood donation and iron supplementation were obtained and venous blood samples were collected for complete blood count and serum ferritin level.* **Results:** *A total 128 female medical students participated in the study, and mean hemoglobin level was 12.6±0.928 g/dL. In the studied group, 14.1% of participants had anemia and IDA was the major cause with a prevalence of 7.8%, while the prevalence of anemia due to other causes was 6.2%. The prevalence of iron deficiency (ID) without anemia was 3.9%. No statistically significant associated factors were found in this study.* **Conclusion:** *The prevalence of IDA among Thai female medical students was low: however, it was the most common cause of anemia and some indicated moderate anemia. Thus, health promotion and screening programs should be considered for IDA prevention and early detection among female medical students.*

Keywords : ● *Prevalence* ● *Iron deficiency* ● *Iron deficiency anemia* ● *Medical student*

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นิพนธ์ต้นฉบับ

ความชุกและปัจจัยที่มีผลต่อการเกิดภาวะโลหิตจางจากการขาดธาตุเหล็ก ในนิสิตแพทย์หญิง

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บทคัดย่อ

วัตถุประสงค์ *เพื่อศึกษาความชุกและปัจจัยที่เกี่ยวข้องของภาวะโลหิตจางจากการขาดธาตุเหล็กในนิสิตแพทย์หญิงไทย* ***วัสดุและวิธีการ*** *นิสิตแพทย์หญิงไทยอายุ 20-25 ปี ตั้งแต่มิถุนายน พศ. 2562 ถึง กุมภาพันธ์ พศ. 2564 โดยเก็บข้อมูลพื้นฐานทางคลินิก พฤติกรรม การบริโภคอาหาร ประวัติประจำเดือน การบริจาคเลือดและการเสริมธาตุเหล็ก เก็บตัวอย่างเลือดดูความสมบูรณ์ของเม็ดเลือดและระดับ เฟอร์ริติน* ***ผลการวิจัย*** *นิสิตแพทย์หญิงไทยจำนวน 128 คน มีระดับฮีโมโกลบินเฉลี่ย 12.6±0.928 กรัมต่อเดซิลิตร มีความชุกของ โลหิตจางร้อยละ 14.1 โดยมีสาเหตุจากขาดธาตุเหล็กร้อยละ 7.8 และสาเหตุอื่นๆ ร้อยละ 6.2 ความชุกของการขาดธาตุเหล็กแต่ไม่มี ภาวะโลหิตจางร้อยละ 3.9 ไม่พบปัจจัยที่เกี่ยวข้องที่มีนัยสำคัญทางสถิติในการศึกษานี้* ***สรุป*** *ความชุกของภาวะโลหิตจางจากขาดธาตุ เหล็กในนิสิตแพทย์หญิงไทยอยู่ในระดับต่ำ แต่เป็นสาเหตุที่พบบ่อยที่สุดของภาวะโลหิตจาง และมีบางรายมีภาวะโลหิตจางรุนแรงใน ระดับปานกลาง ดังนั้น ควรมีการให้ความรู้ ส่งเสริมสุขภาพและตรวจคัดกรอง เพื่อป้องกันและให้การวินิจฉัยภาวะโลหิตจางจากการ ขาดธาตุเหล็ก*

คำสำคัญ : ● *ความชุก* ● *การขาดธาตุเหล็ก* ● *โรคโลหิตจางจากการขาดธาตุเหล็ก* ● *นักศึกษาแพทย์*
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Introduction

Anemia is one of the major global health problems, particularly in developing countries and occurs more commonly in young children and reproductive women. Iron deficiency anemia (IDA) remains the leading cause of anemia with prevalence of 40% among young children and 30% among menstruating girls and women in a systemic analysis of population represent data[1].

Adolescents and young women are at risk of IDA due to several factors included increased iron demand during rapid growth, pregnancy, menstrual blood losses and poor dietary intake of iron due to changes in the eating habits. Other factors associated with low iron status among premenopausal women included vegetarian, low meat intake, excessive menstrual blood loss and low body mass index[2-5].

Poor eating habits are common problems among university students. Meal skipping particularly breakfast, eating out, snack and fast food consumption place them at risk of nutritional deficiency[6]. Ganasegeran, et al. assessed the pattern of eating habits among medical students and found that less than one half (43.9%) had regular breakfast consumption and 35.6% lived alone[7]. Similarly the National Survey of Health Status of Thai Medical students found that 56% of the participants skipped meals and 35% revealed an imbalance of eating of carbohydrate, protein and fat consumption[8].

Medical students may be predisposed to anemia from nutritional deficiency because of having a long schedule of studying, stress of university life and residing in a dormitory away from parents and family members[9,10]. Related studies have reported a high prevalence of IDA among university and medical students[11-15]. Factors associated with IDA included irregular breakfast intake, infrequent consumption of red meat (< 2 times/week) and inadequate iron intake[5,14-16]. However, few studies have been conducted regarding prevalence and risk factor of IDA among Thai female university students. In the present study, we aim to evaluate the prevalence of IDA and associated factors among Thai female medical students.

Materials and methods

The cross-sectional study of 128 healthy female students aged between 20 and 25 years, studying at in Panyananthaphikkhu Chonprathan Medical Center, Nonthaburi, Thailand, was conducted between June 2019 and February 2021. Those with a diagnosis of thyrotoxicosis, d*iabetes mellitus*, cancer, inflammation, autoimmune disease, ischemic heart disease, valvular heart disease, homozygous Hb E, HbH disease, HbH-CS disease, β-thal/HbE disease, homozygous β-thalassemia and those receiving glucocorticoids, salicylate, NSAIDs, proton pump inhibitor, H2 receptor blockers and antacid were excluded from the study.

Data on the participants' sociodemographics, dietary habits, menstrual pattern, history of blood donation and iron supplementation were obtained. Participants were asked to record their protein consumption over seven days. The iron intake was calculated based on dietary records using the Institute of Nutrition, Mahidol University CALculation (INMUCAL) Nutritional Analysis Program, Version 4.0[17]. The venous blood samples for complete blood count and serum ferritin levels were collected on the same day when the questionnaire was completed.

All participants provided written informed consent to acknowledge the purpose of the study and ensure the confidentiality of the results. Ethics approval was obtained from the Panyananthaphikkhu Chonprathan Medical Center's Research Ethics Committee (approval number: EC 008/62).

According to the World Health Organization criteria, iron deficiency anemia (IDA) is defined as Hb < 12.0 g/dL and serum ferritin < 15 µg/L and iron deficiency (ID) without anemia is defined as serum ferritin < 15 µg/L[18]. Body mass index (BMI) was classified as underweight (BMI < 18.5 kg/m^2), normal (BMI 18.5 to 22.9 kg/m^2), overweight (BMI 23 to 24.9 kg/m^2), grade 1 obesity (BMI 25 to 29.9 kg/m^2) and grade 2 obesity (BMI > 30 kg/m^2). A single blood donation was considered as denoting a blood donor. Hypermenorrhea was defined as menstrual duration of more than seven days, need

to change menstrual products every one to two hours or passage of clots[19].

Statistical analysis

　Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) Program, Version 18.0. Descriptive analysis and Inferential statistics were performed for all variables. Continuous variables were expressed as mean±standard deviation, and categorical variables were expressed as frequency and ratio. Comparisons between two groups were analyzed using Fisher's exact test for categorical data and Student's t-test for continuous data. We used Pearson's correlation analysis to investigate relationships. A *p*-value less than 0.05 was considered statistically significant.

Result

　A total of 128 Thai female medical students, mean age 22.7±1.38 year, were included in the study. All participants were 4th to 6th year medical students, and mean BMI was 20.7±2.65 kg/m^2. The frequency of breakfast consumption was reported indicating less than one half (41.7%) had regular breakfast consumption. The majority resided in a dormitory (82%) and exhibited normal menstrual pattern (88%). Most were nonvegetarian and not taking iron supplements (Table 1).

　The mean hemoglobin level was 12.6±0.928 g/dL and 14.1% of the studied population was found to have anemia. Iron deficiency anemia was the main cause with a prevalence of 7.8%, while the prevalence of anemia

Table 1 Baseline characteristics and demographic data

Characteristic	n (%)
Educational level	
4th year	45 (35.2)
5th year	54 (42.2)
6th year	29 (22.7)
Body mass index (kg/m^2)	
< 18.5	21 (16.4)
18.5 - 22.9	86 (67.2)
> 23.0	21 (16.4)
Living arrangement	
Residing in a dormitory (≥ 5 days/week)	105 (82)
Living with family members	23 (18)
Frequency of breakfast consumption weekly	
< 4　days	30 (23.6)
4 - 5 days	44 (34.6)
6 - 7 days	53 (41.7)
Diet	
Nonvegetarian	127 (99.2)
Vegetarian	1 (0.8)
Menstrual pattern	
Normal	113 (88.3)
Hypermenorrhea	15 (11.7)
Iron supplementation	
Yes	5 (3.9)
No	123 (96.1)
History of blood donation	
Yes	14 (10.9)
No	114 (89.1)

Table 2 Prevalence and severity of anemia, iron deficiency (ID) and iron deficiency anemia (IDA) among female medical students (n = 128)

Classification	n (%)
Normal (Hb ≥ 12 g/dL)	110 (85.9)
Noniron deficient	105 (82.0)
Iron deficiency	5 (3.9)
Anemia (Hb < 12 g/dL)	18 (14.1)
Iron deficiency anemia	10 (7.8)
β -thalassemia trait (4.7%)	6 (4.7)
α-thalassemia trait (1.5%)	2 (1.5)
Severity of IDA	
Mild (Hb 10.5-11.99 g/dL)	5 (50.0)
Moderate (Hb 8-10.49 g/dL)	5 (50.0)

from other causes was 6.2%. Other causes of anemia included β *thalassemia trait* (4.7%) and α *thalassemia trait (1.5%)* (Table 2). The prevalence of iron deficiency (ID) without anemia was 3.9% (Table 2). In the iron deficiency anemia group, mild and moderate anemia were found 50% equally with a mean hemoglobin level of 11 and 10 g/dL, and a median serum ferritin level of 9.81±5.05, and 6.14±7.11 µg/L, respectively.

When comparing between iron deficient and noniron deficient groups, no statistically significant difference was found in BMI, frequency of breakfast consumption, living arrangement, menstrual pattern and estimated iron intake. (Table 3). As shown in Figure 1, no association was noted between estimated iron intake and serum ferritin level (r = 0.086, *p* = 0.752)

Discussion

The present study determined the prevalence of IDA and associated factors among Thai female medical students. As far as we are aware, this constitutes the first study in Thailand investigating the prevalence of IDA among Thai medical students. In the present study, the prevalence of anemia and IDA were 14.1 and 7.8%, respectively, which were lower compared with related studies. In a study in Saudi Arabia, prevalence of anemia among female medical students was found at 38.3%[20]. Similarly in Pakistan, 33.4% of female medical students were found to be anemic[13]. Moreover, another

study from India showed a large proportion of female medical students (43%) had anemia[12]. The burden of anemia is widely known to be associated with socio-economic status which was lower in countries with higher socio-economic status[21]. Most related studies have investigated in low to lower to middle income countries while Thailand had moved up from the lower to middle income to an upper to middle income country. Data from the Thai National Health Examination Survey (NHES) VI, conducted in 2020, reported the prevalence of anemia among women aged 15 to 29 years was 16.1% which tended to decrease compared with a related survey. Furthermore, in Thailand plenty of foods are available in hospital cafeterias, food delivery services and convenience stores around campus; thus, food access is convenient.

Poor eating habits and menstrual blood loss are potential risk factor of IDA among university students. Furthermore, medical students may be predisposed to anemia from nutritional deficiency because of having long schedule of studying, stress of university life and residing in a dormitory away from parents and family members. Related studies demonstrated numerous factors associated with IDA. Irregular breakfast intake has been reported as being a significantly associated factor of IDA among university students in several studies[5,14,22]. Students who skip breakfast were demonstrated to have a higher prevalence of IDA. Other factors included low

Table 3   Factors associated with iron deficiency

Characteristic	Iron deficient (n = 15)	Noniron deficient (n = 113)	*p*-value
Age (year)	22.7±1.05	22.76±1.43	0.805
4th year	6 (40.0)	39 (34.5)	0.911
5th year	6 (40.0)	48 (42.5)	
6th year	3 (20.0)	26 (23.0)	
BMI (kg/m^2)	20.20±1.66	20.84±3.04	0.423
< 18.5	1 (6.7)	16 (14.1)	0.046
18.5 – 22.9	13 (86.6)	77 (68.1)	
≥ 23.0	1 (6.7)	20 (17.8)	
Frequency of breakfast consumption weekly			
<4 days	5 (33.3)	25 (22.1)	
4 - 5 days	3 (20.0)	41 (36.3)	0.400
6 - 7 days	7 (46.6)	46 (40.7)	
Living arrangement			
Residing in a dormitory	13 (86.7)	92 (81.4)	0.738
Living with family members	2 (13.3)	21 (18.6)	
Menstrual pattern			
Normal	12 (80.0)	101 (89.4)	0.384
Hypermenorrhea	3 (20.0)	12 (10.6)	
Iron supplementation			
Yes	0 (0)	5 (4.4)	0.635
No	15 (100)	108 (95.6)	
History of blood donation			
Yes	1 (6.7)	13 (11.5)	0.573
No	14 (93.3)	100 (88.5)	
Estimated iron intake in 7 days (mg)*	3.19 (6.28)	5.62 (9.32)	0.068

Data presented as mean±SD or proportion (%) *p*-value < 0.05;   *Data presented as median (IQR)
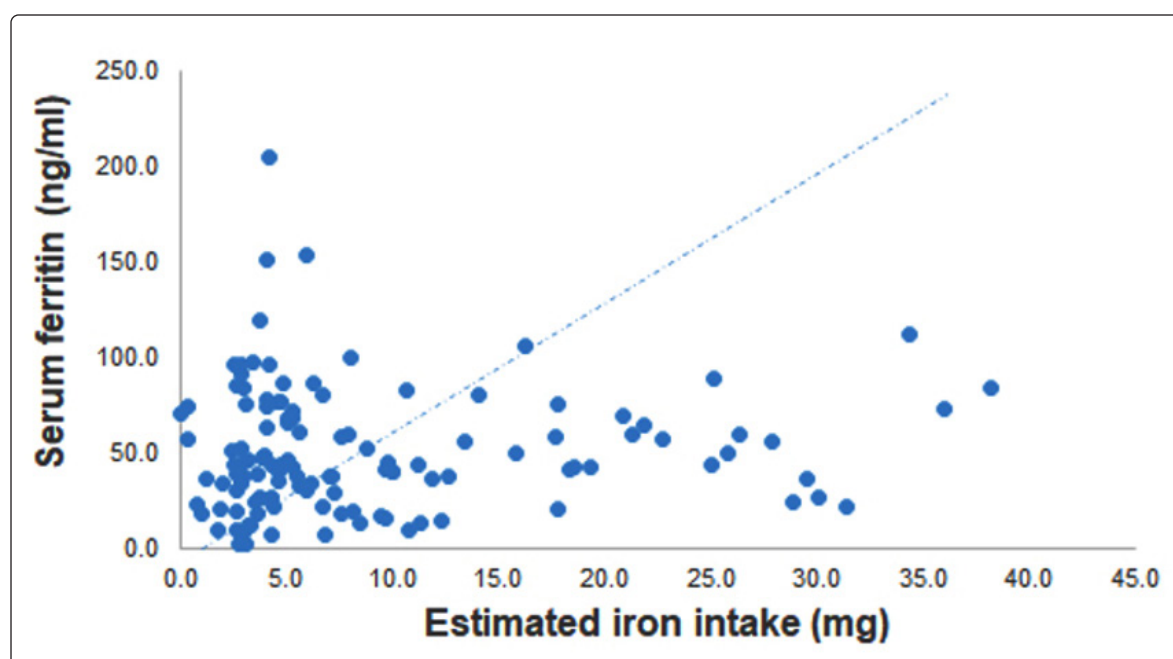
Figure 1   Correlation between estimated iron intake in 7 days and serum ferritin level

intake of fruit and vegetables, infrequent consumption of red meat and increasing tea consumption. However, no significant associated factor with iron-deficient was found in our study which was similar to a related study in Saudi Arabia[20].

Although estimated iron intake between iron deficient and non-iron deficient groups in the present study did not significantly differ, iron intake in the iron-deficient group tended to be lower. Inadequate iron intake is not the only determining factor of IDA. Another predisposing factor is food that enhances or inhibits iron absorption. Excessive oxalate and tannin intake inhibit iron absorption while ascorbic acid is an enhancer.

The present research found no association between estimated iron intake and serum ferritin level similar to related cross-sectional surveys[23]. One large cohort study in the Netherlands revealed the association between dietary intake of heme iron with serum ferritin and hemoglobin levels[24]. Those with higher heme iron intake and lower nonheme iron intake had higher hemoglobin and serum ferritin levels. In the present study, our dietary record did not categorize heme and nonheme iron.

Several limitations were encountered in our study. First, the study was conducted among medical students of only one campus in an urban area; thus, the results of our study limited generalizability. Second, the sample size of this study was too small and prevalence of IDA was lower than we hypothesized, so we could not identify the associated factors. Finally, the dietary records were based on self-reporting and estimated iron intakes were not calculated by a nutritionist; thus the collected data might not be entirely accurate.

Conclusion

The prevalence of IDA among Thai female medical students was low. However, it constituted the most common cause of anemia and some subjects had moderate anemia. Thus, health promotion and screening programs should be implemented for IDA prevention and early detection among female medical students.

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