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Iron deficiency in women of reproductive age of Pekutatan Subdistrict, Jembrana, Regency Bali: association with demographic profiles

Ketut Suega,* Indah Elyani

ABSTRACT

Background: Iron deficiency anemia is anemia that occurred due to reduction of total iron content. The high-risk groups are women of reproductive age (WRA), pregnant women, students, and adolescents. The aim of this study was to know the prevalence of iron deficiency and its association with level of education, meat consumption, and menstrual pattern.

Methods: A population-based study using analytic cross-sectional study was done. Simple random samples were drawn from list of all WRA population statistical data in Pengeragoan Village, Pekutatan Subdistrict, Jembrana. WRA between 20 and 49 years with their demographic data, meat consumption pattern, menstrual pattern, and level of education were taken using questionnaire. Ferritin level < 20 ug/dl is considered iron deficiency state. All the data were examined with significance level < 0.05.

Results: Out of 790 WRA registered, 80 subjects were recruited. Only 1 (1.25%) subject was found having abnormal menstruation pattern and 5 (6.25%) of them were found having anemia. Low ferritin serum < 20ug/dL was found in 11 subjects, so iron deficiency prevalence was 13.75%. Mean ferritin serum was 64.45 ± 3.95 ug/L (range 5.3-150 ug/L). This study found no relationship was noted between meat consumption, level of education and menstrual pattern, and ferritin level in WRA subjects ($p > 0.05$).

Conclusion: Iron deficiency was found to be 13.75% and no association was discovered between level of ferritin serum and meat consumption, level of education, and menstrual pattern.

Keywords: Iron Deficiency, Ferritin Level, Meat Consumption, Education, Menstrual Pattern

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Hematology and Medical Oncology Division
Department of Internal Medicine
Udayana University/Sanglah Hospital
Denpasar Bali

*Correspondence to: Ketut Suega
ksuega@yahoo.com

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INTRODUCTION

Iron deficiency is started with body iron store depletion and then becomes worse into iron deficient erythropoiesis and finally iron deficiency anemia. The high-risk groups are women of reproductive age (WRA), pregnant women, students, and adolescents.[1,2] The most common etiology of iron deficiency is deficiency in iron uptake and/or iron loss due to chronic bleeding. Blood loss from menstruation is the most common etiology in WRA.[1,3] Clinical manifestations of iron deficiency appeared late because it can be tolerated well. WRA with iron deficiency without anemia can develop into iron deficiency anemia during pregnancy as a consequence of increasing in iron demand and plasma volume.[4]

Iron deficiency is the most common nutritional problem in the world. In the United States, iron deficiency most frequently happens in juvenile (7%) and adult women (9-16%). Iron deficiency anemia is anemia that occurred due to reduction of total iron content. Reduction of total iron content can lead to iron storage depletion and decreasing the iron supply for erythropoiesis process. Nearly almost 2 billion people, one-third of global population, are anemic. Despite advancement in health technologies in recent years, there has been insignificant reduction in the world prevalence of anemia. The World Health Organization (WHO) reported globally that 42% of pregnant women, 30% of nonpregnant women (aged 15 to 50 years), 47% of preschool children (aged 0 to 5 years), and 12.7% of men older than 15 years are anemic. WHO estimates that, in 2004, iron deficiency anemia (IDA) resulted in 273,000 deaths: most of the cases occurred (97%) in the developing countries. It also could cause economic loss approximately 4% of gross domestic product (US dollars).[5]

Health problems related to iron deficiency in productive age female were as follows: 1) around 20% of death cases of pregnant women and neonates were caused by iron deficiency anemia and risk of mother and perinatal death was decreased by 25% for every 1 g increase of hemoglobin (Hb); 2) anemia in pregnant women caused low-birth weight baby and high-risk of perinatal death.[6] Also a study in Khartoum, Sudan, reported that nonpregnant WRA between 15 and 45 years old have mean ferritin serum that was 28 ± 23 ug/L, mean of Hb that was 11.5 ± 2.1 g/dL, and the iron deficiency prevalence that was 32.1% with subclinical iron deficiency of 20%. It also reported that age did not have any significant association with ferritin serum.

Several other studies have been conducted in order to discover the risk factors that strongly related to iron deficiency but many of them come up with inconsistency of the findings. Foo (2004) did research finding the determinant factor for iron status in Malaysia in population living at the village and found that mean ferritin serum in nonpregnant adolescents was 15.4 ± 5.8 ug/L and 49.5% of sample population had ferritin serum below normal level. This research also showed that, in women, iron intake was a significant determinant factor influencing ferritin serum level.[7] Pasricha et al. (2008) studied iron deficiency anemia, meat consumption, and hookworm infection from nonpregnant WRA in Vietnam. It showed that, from 349 subjects, 37.5% had anemia and 23.10% had ferritin serum less than 20 ng/L. Meat consumption had a significant correlation with Hb concentration and iron store index while worm infection did not have any significant correlation. Meat consumption at least four times weekly could prevent anemia and was related to the formation of ferritin.[8] Dandekar (2009) during his research in India about the correlation between ferritin serum and menstrual pattern from nonpregnant WRA found that bleeding duration had a negative correlation with ferritin serum.[9]

Until now, there were very limited studies about iron deficiency prevalence in Indonesia especially in WRA group. Most of the studies pointed out iron deficiency prevalence in pregnant women, infants, and toddlers. Iron deficiency prevalences reported in Indonesia were 26.50% in young women, 26.9% in reproductive age women, 40.1% in pregnant women, and 47.0% in toddlers. According to public health problem classification, this prevalence in WRA was classified as moderate category and it was found to be higher in rural than in urban residents.[10]

Bali consisted of 8 regencies and 1 municipality in which one of the regencies was Jembrana. Survey result from pregnant women with anemia in Bali from 1997 to 1998 found that the highest percentage of anemia cases in pregnant women was found in Jembrana (65.4%) compared with other regencies in Bali. The percentage of pregnant women in Bali was 46.2%. Regarding these problems, a study to find out iron store status in WRA at Pengeragoan Village, Pekutatan Subdistrict, Jembrana Regency, Bali, and its association with level of education, meat consumption, and menstrual pattern with iron store status was conducted.

METHODS

A population-based study using analytic cross-sectional study was done to discover the prevalence of iron deficiency in WRA and its risk factors. The aim of this study was to know the prevalence of iron deficiency and association between level of education, meat consumption, and menstrual pattern with iron store status in WRA from Pengeragoan Village, Pekutatan Subdistrict, Jembrana. Samples were drawn from list of all WRA population statistical data in Pengeragoan Village, Pekutatan Subdistrict, Jembrana; then a names list of samples was made that included inclusion criteria and labeled with number. Sample was taken using random table. According to population statistical data at the Office of Pengeragoan Village, Pekutatan Subdistrict, Jembrana, there were 790 women of productive age female age between 20 and 49 years old. Based on the study by Foo et al. (2004) 49.5% of adult females had less ferritin level with mean ferritin serum 15.4 ± 5.8 ug/L, sample size in this study was calculated using the formula for cross-sectional study, and 80 WRA were considered suitable.[7]

This study was done after ethical clearance from the Educational and Research unit in the Medical Faculty of Udayana University and permission for doing research from Pengeragoan Village headman, Pekutatan Subdistrict, Jembrana, has been received. Each of the WRA was informed in detail of the goals, benefits, and possible risks caused from this study. Those who voluntary agreed were asked to sign the informed consent. WRA between 20 and 49 years old who met the inclusion criteria, demographic data, meat consumption pattern, menstrual pattern, and level of education data were taken using questionnaire guidance. Ten cc of venous blood sample from cubital vein was taken aseptically from all subjects using 10 ml disposable syringe for ferritin serum level examination with immunochemiluminescent method with Immulite 2000. Ferritin level < 20 ug/dl is considered iron deficiency state. All data collected were examined for analysis with significance level < 0.05.

RESULTS

Out of 790 WRA registered, 80 subjects were recruited. Demographic profiles of subjects such as weight, age, and BMI were shown in Table 1. Only 1 (1.25%) subject was found having abnormal menstruation pattern and 11(13.75%) with low ferritin level.

Iron Deficiency Prevalence Totally 80 WRA were studied whereas 11 subjects had low ferritin serum < 20ug/dL so iron deficiency prevalence was 13.75%. Mean ferritin serum was 64.45 ± 3.95 ug/L (range 5.3-150 ug/L). Figures 1 and 2 showed the number, age distribution, and ferritin level in WRA.

Table 1 Characteristic of subjects

Characteristic of subjects	Number
BMI	
<19 (underweight)	14
19-25 (normal)	41
>25 (overweight & obesity)	25
Age	
20-30	23
31-40	28
>40	29
Education	
Elementary	42
Primary high school	26
Secondary high school	11
University	1
Occupation	
Government worker	
Farmer/labour	62
Private worker	4
Others	14
Duration of menstruation	
2-7 days	79
>7 days	1
Number of daily napkins needed	
2-3	79
>6	1
Meat consumption	
High	71
Lower	9
Hb level	
Normal	75
Anemia	5
Ferritin serum	
Normal	69
Lower	11

Table 2 Distribution of meat consumption and ferritin level in WRA

	Low ferritin	Normal ferritin	Total
Low meat consumption	1	8	9
High meat consumption	10	61	71
Total	11	69	80

DF =1 Chi-squarep > 0.05.

Table 3 Distribution of educational status and ferritin level in WRA

	Low ferritin	Normal ferritin	Total
Low education level	7	30	37
High education level	4	39	43
Total	11	69	80

DF=1 Chi-square p > 0.05.

Table 4 Distribution of menstrual pattern and ferritin level in WRA

	Low ferritin	Normal ferritin	Total
Abnormal menstruation	1	0	1
Normal menstruation	10	69	79
Total	11	69	80

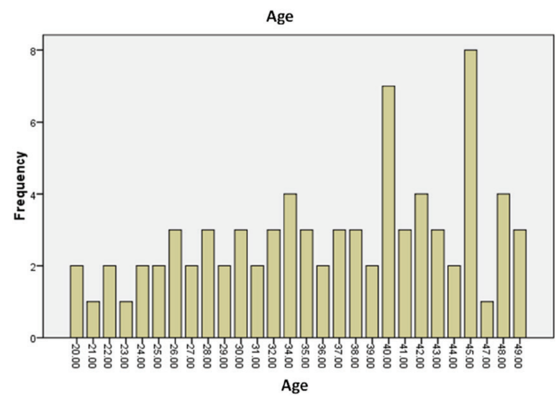

Figure 1 Distribution of age in WRA

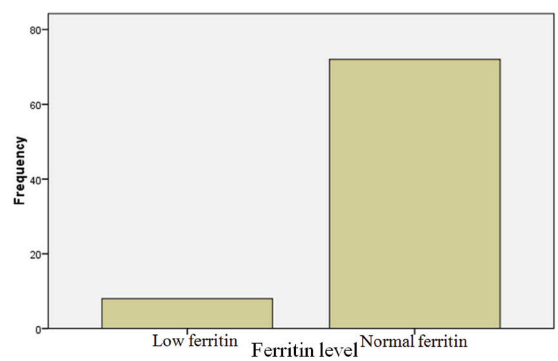

Figure 2 Distribution of ferritin level in WRA

Level of Meat Consumption and Iron Store Status in Women of Reproductive Age

This research found that 71 (88.8%) subjects with high level of meat consumption and 61 of them (85.9%) had normal ferritin serum while 10 (14.1%) had low ferritin serum. In 9 subjects with low meat consumption low ferritin serum was found in only 1 subject (Table 2).

This study indicated no relationship was found between meat consumption and ferritin level in WRA subjects.

Level of Education and Iron Store Status in Women of Reproductive Age

We found 43 (53.8%) subjects had high level of education while 37 (46.2%) subjects had low level of education. In 37 subjects with low level of education low ferritin serum was found in 7 (18.9%) subjects. But no significant relationship was found between education status and ferritin level (Table 3).

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Menstrual Pattern and Iron Store Status in Women of Reproductive Age

Out of 79 subjects with normal menstrual pattern, 10 had low ferritin level. In only one subject with abnormal menstrual pattern, low ferritin serum was found (Table 4).

According to Fisher exact and Chi-square test result of 0.138 with $p > 0.05$, the study did not find significant contributing role of abnormal menstrual pattern in the development of iron deficiency in WRA.

DISCUSSION

Iron Deficiency Prevalence

Iron deficiency caused functional disturbances due to reduction of hemoglobin and myoglobin synthesis lead to disturbance of peripheral oxygen distribution and decreasing of some iron-containing enzyme activities. Many biochemical processes and metabolism especially oxidative metabolism would be influenced and caused suboptimal physiological functions and health disturbances such as working capacity and reproductive efficiency, psychomotor and cognitive development, immune function, and infection. With the worsening of disturbances in iron deficiency, iron stores would become scarce and followed by increasing risks toward functional disturbances. Transferrin saturation less than 16% showed erythropoiesis in jeopardy and worsening of iron deficiency decrease hemoglobin level and development of anemia.[11]

From 80 subjects involved in this study, iron deficiency prevalence in WRA was found to be 13.75%. This number is lower than that of data from Indonesian Health Department (2008) which reported that iron deficiency prevalence of WRA in Indonesia was 26.9%.[10] According to Indonesian Household Survey (SKRT) in 2001, the prevalence of anemia in WRA in Bali is 19% whereas that in Banten is 43%. A study by Ani et al. (2010) reported that iron deficiency of WRA who just get married was 47.1% and 36.3% of those were suffered anemia. Another study on high school female also showed higher number of anemic patients (36.7%).[12] Countries or areas with prevalence more than 10% in one or more vulnerable groups were considered as an area with public health problem.[13] Around 30%–50% of anemia cases in children and other groups are caused by iron deficiency. Nearly almost 2 billion people are anemic, where one-third of them manifest iron deficiency anemia. Hence, iron deficiency is the most important anemia globally. Low-income countries as well as the place where this study was conducted witnessed the highest number of anemia cases encountered and the cases are not distributed evenly throughout the world. In some global regions, the prevalence of anemia among young children is 50% and even approaches 100% in some locales. But the disease burden much more lessens in westernized nations. In Northern America, the prevalence of anemia is reducing; however, almost 10 million people are iron deficient with half of them having iron deficiency anemia in the United States.[14]

The management program for anemia in WRA was done using 2 main activities, that is, information, education, and communication (IEC) and iron supplement tablets. Iron supplementation given for pregnant women is ineffective because the iron store status in prepregnant WRA has already been low; therefore the management strategy for anemia should be started earlier in young teenager women entering the reproductive age.[15] This study's results could be used as evaluation for this program. This study showed the small success of this program which was marked by the decreasing of iron deficiency prevalence in WRA at Jembrana Regency which is known from previous study that reported the prevalence of anemia in pregnant women is approximately 65.4%, however not in terms of direct effect but the trend toward decreasing the prevalence of iron deficiency or iron deficiency anemia.[16]

Women of reproductive age are at increased risk of having iron deficiency because of regular menstruation, whereas pregnancy and childbirth result in a net iron loss of 580 to 680 mg because of fetal and placental requirements and bleeding during delivery. In addition, maternal iron stores can influence birth weight and duration of gestation: low-birth weight or premature infants are born with lower iron stores and, thus, are at increased risk of IDA. Because every single one of the WRA should be aware and encouraged to have iron supplementation when necessary, without knowledge of these reasons, pregnant and nonpregnant WRA are at increased risk of having iron deficiency.[5]

Level of Meat Consumption and Iron Store Status in Women of Reproductive Age

Risk factors studies for iron deficiency anemia showed that several factors influence the development of anemia such as education, female gender, demographic area, food intake and meal habit, health status, and body mass index.[17] These risk factors could influence the preference for iron deficiency in WRA. This study's results showed that most subjects had high level of meat consumption and no correlation was found between level of meat consumption and iron store status. This is supposedly due to in part the subjective questionnaire used to measure the level of meat consumption by recording its frequency. This semiquantitative food record method gave a chance for memory bias.

Determining the amount of iron absorbed from certain diet is difficult to do, so a universal approach is needed to define iron demand using factorial method based on the estimation of iron loss, loss during menstruation, and iron loss from its tissue-processing. All of these factors may be limiting the conviction from which the number of iron demands is determined. Iron demand from diet is estimated using the number for absorption and systemic utilization of iron from certain diet. And, in most cases, determination of iron from diet was based only on short term study from people with normal iron level. Iron absorption in these people is lesser; hence bioavailability potency from studied diet is inaccurately reflected. The other uncertainty is caused by less data from certain population groups, difficulty in comparing between long term and short term study, and problems in measuring the amount of iron loss during menstruation including its variability in each person. Besides, the interaction between diet components in these whole foods would also influence the absorption process such as a stimulator or inhibitor element from iron absorption processes in certain diet.

Iron from diet is found in 2 forms as heme iron and nonheme iron. Heme iron is usually found in animal products, as hemoglobin and myoglobin and nonheme iron found in animal and plant's tissues as a Fe^{2+} bound to insoluble protein, phytate, oxalate, phosphate, and carbonate and also as ferritin. The richest source of nonheme iron is found in cereal, vegetables, peanuts, egg, fish, and meat. Heme iron absorption from diet is more efficient than nonheme absorption; intestinal absorption from dietary iron is principally influenced by systemic iron demand. More iron is absorbed from diet in iron deficiency condition, and vice versa. Knowledge about the association between food modulator (stimulator and inhibitor) and iron absorption and iron status is based on observational data with some limitations. Some researches found inconsistency in estimating (too high or too low) the effect of food modulation for nonheme iron absorption. It is owing to the efficiency of absorption that is maximalized after one-night fasting, the effect of key mediator which could be substantially solved during consumption with another food as a part of whole food, and the intestinal setting for absorption and transfer of iron that needed time to adapt to food changing during longer period of time. Although epidemiological research has also put into account the adaptive and complexity response of whole food, the correlation between food element and iron status could be misleading. The measured effect of food's stimulator and inhibitor can only be observed in persons with the increasing demand for systemic iron.[18] The complexity between iron consumption and iron status is even more complex added by contaminating factors that influenced iron absorption such as age, homeostasis of metabolic response, loss during menstruation, and genetic factor (like HFE and other polymorphisms).

A longitudinal research for 10 years in the United States (n=125; 60-93 years old) is done to find out the effect of heme and nonheme iron intake on body iron store.[18] No significant association is found between dietary iron intake (heme and nonheme) and estimated iron store. But supplementary iron intake had significant association (p=0,04) with the increasing of iron store if compared with those who did not consume iron supplement. Some cohort studies in Mexico, the United States, and Sweden by Ohund et al. (2008) reported that inconsistent result is found regarding the association between daily food's type and parameter of iron status but a significant correlation between ferritin serum concentration and meat intake only in boys (p=0,015) is found. Some other studies did not find any correlation between low hemoglobin level and iron intake either heme or nonheme and association between nonheme iron intake and high ferritin level.

Level of Education and Iron Store Status in Women of Reproductive Age

This study showed that most subjects had high level of education. No association was found between level of education and iron store status and this was supposed to be because understanding about factors related to iron deficiency has already been known about subjects with low level of education. They have it through intensive information, education, communication given by available health services, and information from mass media. Besides, in every health service, the health practitioners were obliged to give information regarding anemia in pregnant women.

One research in Johor, Malaysia, also reported that there was no significant difference between level of education and anemia in pregnant women with p=0,62.[19] The same result was also found in research at Sapa Village, South Minahasa, Indonesia, with p=0,72.[20] Nonetheless others reported significant correlation was found between level of mother education and anemia in pregnancy.[16]

High level of education is believed to give more knowledge for mother about health problems including prevention and management of anemia; besides mothers with high level of education were historically supported with social economy aspects and better income. Education is important for one's

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thinking pattern including his behaviour in making decision to choose a better and more healthy food and, for example, choosing and processing foods containing iron. It is also believed that women who have better education have better health access as well.[20]

As known, the causes of iron deficiency anemia could be seen from some aspects, both direct and indirect. In the population-based study, IDA can have direct and indirect determinants. Direct determinants such as intestinal iron are taken limited by food factors (heme or nonheme iron and also influence by food modulators) and host factors (iron status and genetic makeup of iron modulator protein (e.g., TMPRSS6). Women in pregnancy require iron to exceed 1 g, and every delivery process will also lose iron approximately 580 to 680 mg, while indirect determinants such as poor iron diet, intake of nonheme iron, and consumption of iron inhibitors (cereals and grains) can lead to iron deficiency. People live in developing countries with low-income (especially rural) settings iron-rich foods almost unaffordable. Bad hygiene and human waste promote parasitic (including hookworm) infection and schistosomiasis. Access to health care, anemia control policies, sanitation practices, agricultural practices, and, ultimately, prevailing economic, political, and environmental conditions are among the important factors that influence iron metabolism in WRA.[5]

Menstrual Pattern and Iron Store Status in Women of Reproductive Age

Duration of menstruation is usually around 3-5 days and is considered abnormal if it lasts for more than 7 days. There is a blood loss during menstruation. The longer the duration of menstruation is, the more the blood will be finally lost. Loss of lots of blood increased iron loss and caused iron deficiency. The amount of menstrual blood loss indirectly known by the number of sanitary napkins is used every day. It is classified as abnormal if the sanitary napkins are changed every 3 hours or more than 6 times daily.[21,22]

Iron is not actively excreted from our body through urine or intestine, iron loss together with cells from skin, mucous membrane, urinary tract, and respiratory tract. The estimated amount of iron loss was 14 micrograms/kgBW/day. In children daily iron loss is related to the body surface area. A nonmenstrual woman with body weight 55 kg would lose 0.8 mg iron/day and a man with body weight 70 kg would lose 1 mg iron/day. The range of individual variation is estimated to be ± 15%. Iron loss during sweating is considered, especially in hot and moist climate. However, based on the newest research that applied extensive protection to prevent interference of iron contamination from skin during the collection period of total body sweats, iron loss through sweating can be abandoned.[23]

Iron loss during menstruation is slightly constant in every woman but has a significant variable between one woman and another. The main part of this variation is a genetic problem which is controlled by fibrinolytic activator within mucous membrane of uterus across population in geographically far separated population (Burma, Canada, China, Egypt, England, and Sweden). This finding suggested strongly that the main source of iron status variation from different population is not associated with variation in demand but variation in dietary iron absorption. The amount of menstrual iron loss during the whole menstrual cycle for 28 days is around 0.56 mg per day. In addition to basal iron loss (0.8 mg/day) and its variation, distribution of total iron demand in women can be counted as a total amount between distribution of menstrual and basal iron loss. The mean daily iron requirement is 1.36 mg, for 10% of women the requirement increased to 2.27 mg, and in 5% of women requirement is 2.84 mg.[11] In 10% of young adult women (during growth period), daily total iron demand could reach 2.65 mg and in 5% young adult women could reach 3.2 mg. Due to the skewness of normal distribution in menstrual iron loss, it could be a huge nutritional problem because the estimation of individual iron loss could not be fully trusted. It meant that women with physiological iron loss but in severe form could not be identified and managed with iron supplementation.

Menstruation, pregnancy, lactation, and adolescence growth would influence iron metabolism and iron demand from diet. Menstrual iron loss is the important factor that determined iron store status in women of reproductive age. Some studies had observed the association between ferritin serum level and duration of menstrual period. Harvey et al. (2005) reported a strong negative correlation between menstrual iron loss and ferritin serum level in which high menstrual iron loss causes low ferritin serum level ($p<0{,}001$).[24] The mean increase of 1 mg/day of menstrual iron loss decreases ferritin serum level by 7 ug/L. Menstrual iron loss is also influenced by contraception method used in which there was increased iron loss when using intrauterine device (IUD) while decreasing when oral contraception is used. Iron loss from menstruation and other sources is very difficult to accurately measure due to inaccurate report from patients and conclusions from qualitative or semiquantitative study are difficult to ascertain. A study in Sweden reported that menstrual iron loss in women has abnormal distribution (skewness to the right side) in which 95% of women would lose 118 cc blood or less in every cycle. The mean menstrual iron loss is around 44 cc with median 30 cc, and it is equivalent to iron loss around 0,7 mg/day with median 0,49 mg iron/day. Harvey et al. (2005) found that the menstrual iron loss was around 26 ml in every cycle which was equivalent to 0,43 mg iron every day and around 70% women had iron loss < 0,5 mg per day. This study also found that women with oral contraception had less blood loss than those with other contraceptives (p<0,001).[25] The long term consequences of menstrual iron loss for around 20-30 years would cause iron deficiency anemia, and therefore this menstrual iron loss should be considered as a pathological loss and managed properly. The risk for having iron deficiency anemia in women with more blood loss during menstruation was 1.81 times bigger than those with less blood loss.[25]

This study result showed that abnormal menstrual pattern was not a significant risk factor for iron deficiency in women of reproductive age. It is quite contradictory to the well-known knowledge that prolonging menstruation with more blood usually was followed by anemia. This is supported by the study of Asakura et al. (2009) that extended duration and amount of blood loss during extreme menstruation as a strong predictor for iron deficiency.[26] Dandekar (2009) also reported that duration of menstruation had a significant correlation with ferritin concentration.[9] The risk for iron deficiency increased 6 times in WRA with 6-7 days of menstruation when compared to WRA with 3 days of menstruation or less. Gunatmaningsih (2007) and Prastika (2011) also found that menstruation was associated with iron deficiency anemia. Nonetheless those who found no association between them arguably state that several factors may play their role such as nutrition, physical activities, level of education, family income, and other external factors that fail to control. In this study one possible explanation could be the quantity of blood itself that should be counted instead of counting numbers of napkins used.[27,28]

CONCLUSIONS

Iron deficiency was found to be 13.75% among WRA from Pekutatan Subdistrict, Jembrana Regency, Bali, and no association was discovered between level of ferritin serum and meat consumption, level of education, and menstrual pattern. Hopefully, there will be next research concerning risk factors for iron deficiency in WRA using better measurement tools in order to retain more valid and reliable information.

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