Protein Energy Deficiency Increases the Risk of Anemia in Pregnant Women

D K Mulyantoro*, I Kusrini
Balai Litbang Keselatan Magelang, Badan Litbang Keselatan, Kementrian Keselatan RI, Kapling Jayan Borobudur Magelang Jawa Tengah, Indonesia
*donny.kristanto@yahoo.com

Abstract. Pregnancy is a special physiological period that involves the ingestion of macro and micronutrients in maternal and fetal diseases. Protein-energy deficiency (PED) is the result of the lack of food intake over a long period of (chronic) time in adequate quantity and quality primarily among low socio-economic classes. Meanwhile, anemia is a major nutritional issue for pregnant women in Indonesia that showed inadequate iron intake. This study is aimed to determine the risk of chronic protein-energy deficiency in pregnant women against anemia. 207 pregnant women participated in the cross-sectional study. Anemia was measured by hemoglobin value using the Cyanmethemoglobin method. PED has been identified by measuring the middle-upper arm circumference (MUAC) and measured body height by microtoice instrument. To test the risk of PED to anemia, a multivariate logistic regression analysis was used. The results found that 47.8% of pregnant women with hemoglobin levels < 12 g/l (anemia). MUAC < 23.5 cm (PED) 16.9 % and body height < 150 cm (stunted) is 44.4%. After adjusted with gestational age and height factors, PED has a risk of 2.18 fold to anemia. Protein-energy deficiency in pregnant women may increase the risk of anemia.

1. Introduction
Nutritional adequacy during pregnancy affects both mothers and fetuses health [1]. The mother needs food intake in adequate quantity and quality during pregnancy. In low and middle countries many pregnant women have an insufficient nutritional intake that may lead to a detrimental effect. Previous research showed that many pregnant women in low- and middle-income countries also have an inadequate dietary intake of vegetables, meat, dairy products, and fruit [2].

Iron deficiency among pregnant women is considered to be the most common nutritional deficiency [3]. A low diet in animal source of foods is the cause of the lack of protein and iron intake among pregnant women. Global coverage for prevalence data shows that anemia in pregnant women was estimated at 38.2% in 2011[4]. WHO reports that 40 % of pregnant women worldwide suffer from anemia [5]. About 56 % of pregnancy anemia occurs in low- and middle-income countries [6]. Based on the basic health survey in 2013 and 2018 data. Indonesia indicates an increased prevalence of anemia in pregnant women by 37.1% to 48.9% respectively [7], [8].

Energy and protein contribute to hemoglobin synthesis. Furthermore, the main protein intake based on food animal source related to Fe intake with high bioavailability [9], [10]. The national total diet study showed the proportion of adequate energy and protein increase in line with the raised wealth index. At the national level, the proportion of pregnant women with low energy levels (< 70% recommended dietary allowance for energy) in the rural area is 52.9%, and in the urban area is 51.5%. The pregnant women with very low protein intake (< 80% recommended dietary allowance for protein) in a rural area 55.7%, while in urban areas is 49.6% [11].
PED pregnant women were measured at less than 23.5 cm of MUAC. The prevalence of PED in women's childbearing age (CBW) was 14.5% in Indonesia in 2018, while it was 17.3% for pregnant women, a slight decrease from PED in pregnant women in 2013 is 24.2% [7], [8]. The presence of protein-energy deficiency in pregnant women can influence iron intake from an animal source of food, so it is necessary to understand the risk of PED against anemia. This study aims to determine the risk of PED to anemia in pregnant women.

2. Methodology

This analysis used secondary data from a cross-sectional hypothyroid study of pregnant women in Magelang [12]. 207 pregnant women were chosen using a simple random sample from 4 subdistricts in Magelang regency. A minimum sample size of 165 is obtained by estimating the proportion of anemia in pregnant women by 48.9 %, a confidence interval (1-α) of 80 and absolute precision of 0.05. Anticipated drop out 20 %, so the minimum sample size is 207 pregnant. Samples were chosen based on inclusion criteria. The inclusion criteria are the samples do not have a complication in pregnancy and have no infectious disease.

Anemia status was measured in serum Hb levels. using the cyanmethemoglobin method. Hb level was < 11 g/l was classified as anemia. A serum sample was analyzed at the Magelang Health Research and Development Laboratory. The PED was categorized using middle upper arm circumference (MUAC) < 23.5 cm and stunting were calculated at body height < 150.1 cm using microtoice.

Analysis and data management is performed using SPSS certified software. Multivariate logistic regression was used to the risk factor of PED to anemia. Ethical approval was obtained by the Ethics Committee of National Institute Health Research and Development Ministry of Health. number LB.02.01/5.2 / KE.340/2015.

3. Results and Discussion

The study was conducted in four sub-districts of Magelang Regency, representative of the mountainous and lowlands areas. The characteristics of pregnant women showed in Table 1.

| Characteristics of Pregnant Women | n=207 (%) |
|----------------------------------|-----------|
| **Education levels**             |           |
| Elementary School (Passed/no)    | 38 (18.4) |
| Junior High School (Passed)      | 76 (36.7) |
| Senior High School (Passed)      | 74 (35.7) |
| Bachelor degree / similar        | 15 (7.2)  |
| Unknown                          | 4 (1.9)   |
| **Husband Occupation**           |           |
| Labourer                         | 72 (34.8) |
| Self employee                    | 64 (30.9) |
| Private Sector Employee          | 38 (18.4) |
| Farmer                           | 17 (8.2)  |
| Civil Governments                | 1 (0.5)   |
| No employee/others               | 9 (4.4)   |
| Unknown                          | 6 (2.9)   |
| **Pregnancy Period**             |           |
| First Trimester 1 (0-12 month)   | 66 (31.9) |
| Second Trimester 2 (13 – 24 month) | 95 (45.9) |
| Third Trimester 3 (25-40 month)  | 46 (22.2) |

This study was performed for pregnant women with a low educational level. Most of the husband's occupations are working in the informal sector, including labourer and small traders as self employee. Almost half of the participants were in the second trimester (13-24 months).
Pregnant women with an upper arm range < 23.5 cm or protein-energy deficiency (PED) have a 2.42-fold risk compared to the normal MUAC of pregnant women.

Almost one of two pregnant women has anemia, with an average of hemoglobin at the lower limit of normal hemoglobin. Approximately one in six pregnant women have MUAC less than 23.5 cm, were classified as protein-energy deficiency. Near half of the participants have less than 150.1 cm and classified as stunted.

Table 2. Nutritional Status of Pregnant Women

| Nutritional Status Indicator | n=207 (%) |
|-----------------------------|-----------|
| Hemoglobin Level            |           |
| Hb <11 gr/l (Anemia)        | 99 (47.8) |
| Hb ≥ 11 gr/l (Normal)       | 108 (52.2)|
| Mean±SD (mg/dl)             | 11.14±1.83|
| Middle Upper Arm Circumference (MUAC) | |
| <23.5 cm (PED)              | 35 (16.9) |
| ≥23.5 cm (Normal)           | 172 (83.1)|
| Mean±SD (cm)                | 26.32±3.43|
| Body Height                 |           |
| <150.1 cm (Stunted)         | 92 (44.4) |
| ≥ 150.1 cm (Normal)         | 115 (55.6)|
| Mean±SD (cm)                | 150.61±5.20|

Variables in the Equation

| Variables in the Equation | B    | S.E. | Wald | Df | Sig. | Exp(B) | 95% C.I. for EXP(B) |
|---------------------------|------|------|------|----|------|--------|---------------------|
| Step 1                    |      |      |      |    |      |        |                     |
| Age 20-35 years old       | 2.79 | 2    | 0.25 |    |      |        |                     |
| Age <20 years old         | 0.51 | 0.55 | 0.88 | 1  | 0.35 | 1.67   | 0.57 (0.37, 0.87)   |
| Age >35 years old         | -0.52| 0.41 | 1.62 | 1  | 0.20 | 0.59   | 0.27 (0.14, 0.54)   |
| MUAC < 23.5 cm            | 0.78 | 0.39 | 3.86 | 1  | 0.05 | 2.17   | 1.00 (1.00, 4.17)   |
| Body Height < 150.1 cm    | 0.08 | 0.29 | 0.08 | 1  | 0.78 | 1.08   | 0.62 (0.00, 4.19)   |
| Constant                  | -0.21| 0.21 | 1.05 | 1  | 0.31 | 0.81   |                     |
| Step 2                    |      |      |      |    |      |        |                     |
| Age 20-35 years old       | 2.89 | 2    | .24  |    |      |        |                     |
| Age <20 years old         | 0.54 | 0.54 | 0.97 | 1  | 0.32 | 1.71   | 0.59 (0.39, 0.94)   |
| Age >35 years old         | -0.52| 0.41 | 1.61 | 1  | 0.21 | 0.59   | 0.27 (0.14, 0.54)   |
| MUAC < 23.5 cm            | 0.78 | 0.39 | 3.91 | 1  | 0.05 | 2.18   | 1.01 (1.00, 4.72)   |
| Constant                  | -0.18| 0.17 | 1.10 | 1  | 0.29 | 0.83   |                     |
| Step 3                    |      |      |      |    |      |        |                     |
| MUAC < 23.5 cm            | 0.88 | 0.39 | 5.19 | 1  | 0.02 | 2.42   | 1.13 (1.00, 5.18)   |
| Constant                  | -0.23| 0.15 | 2.32 | 1  | 0.13 | 0.79   |                     |

The multivariate logistic regression analysis shows the risk of PED to anemia adjusted with age and body height. The pregnant women who have PED have a bigger risk to have anemia with 2.42 fold compare to the normal MUAC of pregnant women.

Pregnancy anemia has a detrimental effect on the mother and the fetus. Previous studies have shown iron deficiency anemia associated with the decrement of intellectual potential and efficiency, the increase of vulnerability to infectious diseases, low birth weight, and preterm birth [4].

This study reveals that 16.9% of pregnant women with a protein-energy deficiency (MUAC less than 23.5 cm) which is higher than the national prevalence of PED of 14.5%. The study indicates that pregnant women with an upper arm range < 23.5 cm or protein-energy deficiency (PED) have a 2.42-fold risk to have anemia. Previous studies conducted in Terbanggi Besar district of Central Lampung regency, Indonesia have shown an association between PED and anemia in women of childbearing age (CBW) with risk, 2.3 times compared to women who do not have PED [13]. Another study in Kota Medan, Indonesia showed the risk of PED 4.0 fold to anemia. higher than pregnant women who do not have PED [14]. This finding was consistent with the finding from Eastern Ethiopia [15] and

Table 3. Logistic Regression Analysis Risk of Age Group, PED, Stunted to Anemia in Pregnant Women

| Variables in the Equation | B    | S.E. | Wald | Df | Sig. | Exp(B) | 95% C.I. for EXP(B) |
|---------------------------|------|------|------|----|------|--------|---------------------|
| Step 1                    |      |      |      |    |      |        |                     |
| Age 20-35 years old       | 2.79 | 2    | 0.25 |    |      |        |                     |
| Age <20 years old         | 0.51 | 0.55 | 0.88 | 1  | 0.35 | 1.67   | 0.57 (0.37, 0.87)   |
| Age >35 years old         | -0.52| 0.41 | 1.62 | 1  | 0.20 | 0.59   | 0.27 (0.14, 0.54)   |
| MUAC < 23.5 cm            | 0.78 | 0.39 | 3.86 | 1  | 0.05 | 2.17   | 1.00 (1.00, 4.17)   |
| Body Height < 150.1 cm    | 0.08 | 0.29 | 0.08 | 1  | 0.78 | 1.08   | 0.62 (0.00, 4.19)   |
| Constant                  | -0.21| 0.21 | 1.05 | 1  | 0.31 | 0.81   |                     |
| Step 2                    |      |      |      |    |      |        |                     |
| Age 20-35 years old       | 2.89 | 2    | .24  |    |      |        |                     |
| Age <20 years old         | 0.54 | 0.54 | 0.97 | 1  | 0.32 | 1.71   | 0.59 (0.39, 0.94)   |
| Age >35 years old         | -0.52| 0.41 | 1.61 | 1  | 0.21 | 0.59   | 0.27 (0.14, 0.54)   |
| MUAC < 23.5 cm            | 0.78 | 0.39 | 3.91 | 1  | 0.05 | 2.18   | 1.01 (1.00, 4.72)   |
| Constant                  | -0.18| 0.17 | 1.10 | 1  | 0.29 | 0.83   |                     |
| Step 3                    |      |      |      |    |      |        |                     |
| MUAC < 23.5 cm            | 0.88 | 0.39 | 5.19 | 1  | 0.02 | 2.42   | 1.13 (1.00, 5.18)   |
| Constant                  | -0.23| 0.15 | 2.32 | 1  | 0.13 | 0.79   |                     |
Dera District, Ethiopia [16] and Nepal [17] that showed MUAC less than 23 is found to increase the risk of developing anemia in pregnant women.

Muscle and fat deposits under the skin may reflect energy and protein malnutrition (PED). The transportation of iron into plasma requires protein. Transferring plasma protein plays an essential role in transferring iron to the bone marrow for the synthesis of hemoglobin. Lack of energy and protein disrupts iron transportation to plasma and bone marrow to interfere with the new hemoglobin formation process. Protein also plays a part in the preservation of hemoglobin components and iron absorption in addition to being used in iron transportation [9], [10].

The study also found that the proportion of anemia in pregnant women was 47.8 %. With an average of 11.14 ± 1.83 g/l which means almost half of the pregnant women involved had anemia and that the mean hemoglobin was below the lower limit of normal hemoglobin. This prevalence of anemia in this study does not differ significantly from the national anemia prevalence. In 201z Basic Health Survey (Risksdas) shows that pregnant women's anemia is 48.9% in Indonesia. Overall the prevalence of anemia among pregnant women is 41.8% [8]. While 2016 statistics of the World Bank suggest that the prevalence of anemia worldwide is 40.1% [9].

4. Conclusion
Anemia is the major public health concern, that was showed with one of two pregnant women have anemia. Moreover, protein-energy Deficiency who indicate a lack of macro nutritional intake for a long time has risk two times higher than non PED to have anemia in pregnant women.

References
[1] Fakier A, Petro G, Fawcus S 2017 Mid-upper arm circumference: A surrogate for body mass index in pregnant women. SAMJ 107, 7
[2] World Health Organization Recommendation on nutrition education on energy and protein intake during pregnancy Available from: https://extranet.who.int/rhl/topics/preconception-pregnancy-childbirth-and-postpartum-care/antenatal-care/who-recommendation-nutrition-education-energy-and-protein-intake-during-pregnancy
[3] World Health Organization 2011 Hemoglobin concentrations for the diagnosis of anaemia and assessment of severity Vitamin and Mineral Nutrition Information System Available from:http://www.who.int/iris/bitstream/10665/85839/WHO’NMH’NHD’NMN’11.1’eng.pdf?ua=1 (accessed 18 May 2015)
[4] Peña-Rosas J P, De-Regil L M, Garcia-Casal M N, Dowswell T Daily oral iron supplementation during pregnancy (Review). Cochrane Database of Systematic Reviews 2015. Issue 7. Art. No.: CD004736. The Cochrane Collaboration. Published by John Wiley & Sons. Ltd.
[5] World Health Organization 2020 Anaemia.Available from https://www.who.int/health-topics/anaemia#tab=tab_1
[6] Black R E, Victora C G, Walker S P et al. 2013 Maternal and child undernutrition and overweight in low-income and middle-income countries The Lancet 382 no. 9890 pp.427–451
[7] Badan Litbangkes Kemenkes RI 2013 Laporan Nasional Riskesdas Badan Litbangkes Press. Jakarta
[8] Badan Litbangkes Kemenkes RI 2013 Laporan Nasional Riskesdas Badan Litbangkes Press. Jakarta
[9] WorldBank 2016 Anemia available from (https://data.worldbank.org/indicator/SH.PRG.ANEM)
[10] Laghari Z A et al 2017 Correlation of BMI and MUAC with Anemia among Sindh University Students. Jamshoro. Pakistan. Sindh Univ Res Jour 49 (3). p 553-556
[11] Badan Litbangkes Kemenkes RI 2011 Laporan Study Diet Total. (Badan Litbangkes Press-Jakarta)
[12] Kusriti I, Farebrother J, Mulyantoro D K 2020 Adequately iodized salt is an important strategy to prevent iodine insufficiency in pregnant women living in Central Java, Indonesia. PLOS ONE 15(11): e0242575
[13] Angraini D I, and Wijaya S M 2019 The Analysis of Chronic Energy Malnutrition and Iron Intake with Anemia in Preconception Women of Childbearing Age in Terbanggi Besar
Subdistrict, District of Central Lampung. In The 3rd International Meeting of Public Health and The 1st Young Scholar Symposium on Public Health KnE Life Sciences pp 122–128

[14] Lubis Z, Jumirah, Fitria M 2017 Chronic Energy Malnutrition and Anemia in Pregnant Women in Medan. Conference Paper.

[15] Alene K A and Dohe A M 2014 Prevalence of anemia and associated factors among pregnant women in an urban area of eastern Ethiopia Anemia p 1–7

[16] Derso T, Abera Z, Tariku A 2017 Magnitude and associated factors of anemia among pregnant women in Dera District: a cross-sectional study in northwest Ethiopia BMC Res Notes 10 p 359

[17] Makhoul Z, Taren D, Duncan B, Pandey P, Thomson C, Winzerling J, Muramoto M and Shrestha R 2012 Risk Factors Associated with Anemia, Iron Deficiency and Iron Deficiency Anemia in Rural Nepali Pregnant Women Southeast Asian Journal of Tropical Medicine and Public Health 43 (3) p 735–745