

Hemoglobin and Serum Transferrin Receptor Differences in Pregnant Women in Rural and Urban Areas of Central Java Province, Indonesia

by M. Zen Rahfiludin

Submission date: 04-May-2021 10:16AM (UTC+0700)

Submission ID: 1577415220

File name: A6_-_Hemoglobin_and_serum_transferrin.pdf (559.23K)

Word count: 4764

Character count: 25491



Research Article

Hemoglobin and Serum Transferrin Receptor Differences in Pregnant Women in Rural and Urban Areas of Central Java Province, Indonesia

Mohammad Zen Rahfiludin, Dina Rahayuning Pangestuti and Yudhy Dharmawan

⁴ Faculty of Public Health, Diponegoro University, Jl. Prof Sudharto SH, Kampus Undip Tembalang, Semarang 50275, Indonesia

Abstract

Background and Objective: Pregnant women in rural and urban areas have different nutritional intakes and associated problems. The present study compared hemoglobin and serum transferrin receptor levels, as well as influencing factors, between pregnant women in rural and urban areas in Central Java, Indonesia. **Materials and Methods:** Blood samples were taken from 80 pregnant women in urban and 69 pregnant women in rural areas of Central Java, Indonesia. The cyanmethemoglobin method was used to measure hemoglobin levels and enzyme-linked immunosorbent assay was used to measure serum transferrin receptor. Nutrient intake data was obtained using 24 h recall on 2 inconsecutive days. Food intake data with Recommended Dietary Allowance percentages were measured using cutoff points based on Indonesian nutritional adequacy. Iron-deficiency anemia status was categorized into four groups: iron-deficiency anemia, non-iron-deficiency anemia, non-anemia iron deficiency and non-anemia/no iron deficiency. **Results:** Pregnant women in rural areas had lower income and education levels than pregnant women in urban areas. Intake of iron, vitamin B12 and folic acid were lower in rural areas, while vitamin C and dietary fiber intake were lower in urban areas. While hemoglobin levels did not differ significantly based on area of residence, serum transferrin receptor levels did. **Conclusion:** Iron-deficiency anemia in pregnant women was higher in rural areas. Therefore, pregnant women are recommended to increase intake of high iron foods, particularly heme-iron and maintain a balanced diet.

Key words: Anemia, iron deficiency, pregnant women, rural and urban areas, serum transferrin receptor**Received:** November 01, 2018**Accepted:** February 17, 2019**Published:** June 15, 2019**Citation:** Mohammad Zen Rahfiludin, Dina Rahayuning Pangestuti and Yudhy Dharmawan, 2019. Hemoglobin and serum transferrin receptor differences in pregnant women in rural and urban areas of central Java Province, Indonesia. Pak. J. Nutr., 18: 637-643.⁴ **Corresponding Author:** Mohammad Zen Rahfiludin, Faculty of Public Health, Diponegoro University, Jl. Prof Sudharto SH, Kampus Undip Tembalang, Semarang 50275, Indonesia Tel: +08122889745¹ **Copyright:** © 2019 Mohammad Zen Rahfiludin *et al.* This is an open access article distributed under the terms of the creative commons attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.⁷ **Competing Interest:** The authors have declared that no competing interest exists.**Data Availability:** All relevant data are within the paper and its supporting information files.

INTRODUCTION

Nutrition of pregnant women is a concern since has a substantial influence on fetal development. In Indonesia, the main nutritional problems faced by pregnant women are inadequate protein⁴⁷ and energy intake and anemia, which are known to increase risk of maternal and perinatal mortality and low birth weight¹. Anemia in pregnant women also causes bleeding at the time of delivery². Iron-deficiency anemia (IDA) in pregnant women largely results from low iron stores at the time of conception and/or the amount of iron absorbed during gestation, both of which are frequently insufficient for the increasing requirements of the fetus³. The prevalence of anemia in pregnant women is usually highest during the third trimester as the average total iron content in the body decreases with increased gestational age⁴.

IDA remains the most common nutritional deficiency during pregnancy, particularly in developing countries. The occurrence of anemia during pregnancy is about 40-80% in tropical countries and 10-20% in developing countries⁵. Studies of pregnant women in Zimbabwe, China, India and Mexico between 1996 and 2008 indicated that between 43% and 73% of women were iron deficient and between 7% and 33% of women had IDA³. According to the 2013 Indonesian Health Profile, anemia occurred in 37.1% of pregnant women in Indonesia, with 36.4% in urban areas and 37.8% in rural areas⁶. In Indonesia, pregnant women should have consumed the minimum of 90 tablets of iron supplements during pregnancy, however data in 2016 indicated that only 40.2% of them meet this requirements, which was lower than the national target in 2016 (86%)⁷.

Indonesia is an archipelago with developmental inequalities. For example, Java island is more developed than other islands; however, its health facilities are different in rural and urban areas. Importantly, residential location, rural or urban, can significantly affect several aspects of daily life, especially health. Several studies have shown that mortality, morbidity, malnutrition and infant mortality are more common in rural areas⁸⁻¹⁰. Likewise, research in Bangladesh has shown the nutritional status of women in urban areas was better than that of rural areas¹¹.

While many studies have analyzed anemia by measuring hemoglobin (Hb) levels in pregnant women, comparison of iron status in rural and urban areas according to serum transferrin receptor (STfR) levels is uncommon. STfR is more commonly used to measure the erythropoiesis process and differentiation of bone marrow. Transferrin receptor levels have been shown to increase in IDA and disorders associated with erythroid precursor levels, such as congenital

dyserthropoietic anemia, hemolytic anemia, major thalassemia, myelodysplastic syndrome and recombinant erythropoietin therapy¹². In general, diagnosis of iron deficiency involves conventional laboratory tests to measure iron status, such as serum ferritin and transferrin saturation. However, serum ferritin and transferrin proteins are affected by inflammation, making it difficult to distinguish between chronic disease anemia and IDA (the type that occurs when Fe deficiency is severe enough to reduce erythropoiesis)¹³. Furthermore, STfR has been suggested to adequately measure early tissue iron deficiency.

Indonesian Health Profile Data in 2015 showed the Maternal Mortality Rate was 128.05 per 100,000 births in Semarang City and 93 per 100,000 births in Temanggung Regency, both of which were higher than that of Sustainable Development Goal 3 (70 per 100,000 births). Prevalence of anemia in pregnancy were also high in both locations (Semarang City 18.34%; Temanggung Regency, 9.51%)^{14,15}. The purpose of this study was to compare both Hb and STfR levels between pregnant women living in rural and urban areas of Central Java province, Indonesia. In addition, factors influencing iron status between the groups was also assessed. The difference of STfR between pregnant women in rural and urban areas was never studied before in Indonesia, hence it is the novelty of our study. The result of this study can be a recommendation for prevention strategy for pregnant women, particularly in rural areas.

MATERIALS AND METHODS

Subjects and data collection: The present study used a cross-sectional design to assess iron status in pregnant women living in Semarang City (urban area) and Temanggung Regency (rural area) of Central Java province, Indonesia. A total of 149 pregnant women in their third trimester were included; 80 resided in urban and 69 in rural areas. Data of pregnant women in Temanggung Regency was obtained from a local Community Health Center in Bulu District, while data of pregnant women in Semarang City was obtained from Genuk and Kedungmundu Community Health Centers. Two Health Centers in Semarang City were necessary to increase the number of willing urban participants (both were of similar condition). Ethical clearance (No. 252/EC/FKM/2016) was obtained from the Commission of Ethics of Medical and Public Health Research of the Faculty of Public Health, Ponegoro University (Semarang, Indonesia) to conduct this study and all subjects provided written informed consent prior to inclusion.

Subjects were interviewed face-to-face by the researchers in private. Interviews in rural areas were conducted in the

traditional Javanese, while those in urban areas were either in Indonesian or Javanese. Data collected during interviews included monthly family income and level of education. Level of education was classified into two groups: primary (primary and junior high schools, 9 years total) and secondary or higher (3 years of senior high school and/or up to 4 years of college). Nutritional intake data were obtained using a 24 h recall method for 2 consecutive days and was measured by 6 enumerators who were Bachelor's of Nutrition graduates of 2017 with 2 weeks of training previously. At this time, they have been working as health officer in governmental or non-governmental institution. Food intake was recorded by an enumerator in the form of household portions (e.g., tablespoons, teaspoons, cups, etc.), then converted to gram units and nutritional intake was analyzed using Nutrisurvey software.

Venous blood (about 5 mL) was taken once in the morning between 8 and 10 am. Hb levels were measured using cyanomethemoglobin, while STfR was measured using a Quantikine IV D human STfR Immunoassay[®] and D Systems, Minneapolis, MN, USA) with an enzyme-linked immunosorbent assay Reader 680 by quantitative sandwich technique. The blood analysis was held in Prodia Laboratory (Gorontalo, Indonesia). An Hb level below 11.0 g dL⁻¹ was classified as anemia¹⁶. An STfR greater than or equal to 21.0 nmol L⁻¹ was classified as iron deficiency¹⁷. IDA status was categorized into four groups: IDA (Hb <11.0 g dL⁻¹ and STfR >21.0 nmol L⁻¹), non-iron-deficiency anemia (Hb <11.0 g dL⁻¹ and STfR <21.0 nmol L⁻¹), non-anemia iron deficiency (Hb ≥11.0 g dL⁻¹ and STfR ≥21.0 nmol L⁻¹) and non-anemia/non-iron deficiency (Hb ≥11.0 g dL⁻¹ and STfR <21.0 nmol L⁻¹).

Table 1: Characteristics of pregnant women in rural and urban areas of central Java, Indonesia

Variables	Rural areas (n = 69)	Urban areas (n = 80)	p-value
Age (years)	27 ± 5.8 ^a	28 ± 5.1 ^a	0.154 ^c
Monthly income (rupiahs)	1000 (500-3000) ^b	2000 (500-6000) ^b	0.001 ^d
Level of education			
Primary	56 (37.6%)	25 (16.8%)	0.001 ^e
Secondary or Higher	13 (8.7%)	55 (36.9%)	

^aMean ± standard deviation, ^bMedian (range), ^cIndependent student's t-test, ^dMann-whitney test, ^eChi-square test

Table 2: Nutritional intake of pregnant women in rural and urban areas of Central Java, Indonesia

Variables	Rural areas (n = 69)	Urban areas (n = 80)	p-value
Energy (calories)	2112 ± 337.6 ^a	2,073 ± 396.9 ^a	0.001 ^f
Energy (%RDA)	96.1 ± 20.5 ^a	73.4 ± 17.6 ^a	0.001 ^f
Protein (g)	61 ± 17.7 ^a	84 ± 24.2 ^a	0.117 ^c
Protein (% RDA)	90.3 ± 26.8 ^a	98.2 ± 32.8 ^a	0.003 ^d
Iron (mg)	9.7 (6.0-25.7) ^b	19.6 (6.2-27.3) ^b	0.001 ^d
Vitamin C (mg)	90 (18-281) ^b	42 (1-288) ^b	0.001 ^d
Vitamin B12 (µg)	1.5 (0.3-10.1) ^b	6.3 (0.1-65.4) ^b	0.896 ^d
Folic Acid (µg)	214 (127.0-485.0) ^b	218.5 (96.0-846.0) ^b	0.001 ^d
Dietary fiber (g)	13.7 (7.5-28.9) ^b	7.4 (1.9-21.0) ^b	0.001 ^d

^aMean ± standard deviation, ^bMedian (range), ^cIndependent student's t-test, ^dMann-whitney test, RDA, recommended dietary allowance

Statistical analysis: Data was analyzed statistically using SPSS software³⁴. If the data distribution was normal, an independent Student's t-test was used to assess differences; a Mann-Whitney test, with a significance level of 5%, was used if the distribution was not normal. Meanwhile nominal data were analyzed using chi-square test. Food intake data with Recommended Dietary Allowances percentages were measured using cutoff points based on the 2013 Republic of Indonesia Ministry of Health Regulation No. 75 regarding Indonesian nutritional adequacy. Data were presented as means ± standard deviations or medians unless specified otherwise.

RESULTS

Table 1 shows the characteristics of pregnant women in rural and urban areas of Central Java, Indonesia. The mean age of pregnant women in rural and urban areas was 27.5.8 and 28 ± 5.1 years-old. Age did not differ significantly between rural and urban areas (p = 0.154). Monthly family income in rural areas was lower than in urban areas (p = 0.001). The majority of pregnant women in rural areas only completed a primary education (37.6%), while most pregnant women in urban areas completed secondary or higher (36.9%). Intake of protein, iron, vitamin B12 and folic acid was higher in urban areas, while intake of vitamin C and dietary fiber were higher in rural areas. Mean iron intake was 2.60 times higher (p = 0.003) and median vitamin B12 intake was 4-times higher (p = 0.001) in urban versus rural areas. Although median folic acid intake was slightly higher in urban areas the difference was not significant. In contrast, median vitamin C (p = 0.001) and dietary fiber (p = 0.001) intake were 2-times higher in rural areas versus urban (Table 2).

Table 3: Hemoglobin and serum transferrin receptor levels of pregnant women in rural and urban areas of Central Java, Indonesia

Variables	Rural areas (n = 69)	Urban areas (n = 80)	p-value
Hemoglobin (g dL ⁻¹)	10.9 (7.3-12.8) ^a	11.1 (8.9-14.3) ^a	0.087 ^b
Serum transferrin receptor (nmol L ⁻¹)	24.1 (13.8-58.2) ^a	15.1 (8.6-34.9) ^a	0.001 ^b

^aMedian (range), ^bMann-whitney test

Table 4: Cross-tabulation of residential location with iron-deficiency anemia status in pregnant women from central Java, Indonesia

Residential location	Iron-deficiency anemia		Non-iron-deficiency anemia		Non-anemia iron deficiency		Non-anemia/non-iron deficiency		Total	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Rural areas	22	31.9	12	17.4	26	37.70	9	13.00	69	100
Urban areas	14	17.5	26	32.5	1	1.25	39	48.75	80	100
Total	36	24.2	38	25.5	27	18.10	48	32.20	149	100

There was a significant difference between STfR levels in pregnant women from rural and urban areas ($p = 0.001$). The median STfR in urban areas was 15.1 (range, 8.6-34.9), which was lower than that of rural areas (median, 24.1; range, 13.8-58.2). Although, Hb levels in urban areas were slightly higher than that of rural areas, the difference was not significant (Table 3). In rural areas, the prevalence of IDA and non-iron-deficiency anemia was higher than that in urban areas. Cross-tabulation showed a correlation between the residential location of pregnant women (urban or rural) and the four IDA status categories ($p = 0.001$). Pregnant women with IDA were more prevalent in rural areas, while in urban areas, most were non-anemic/non-iron deficient (Table 4).

DISCUSSION

The most common cause of anemia during pregnancy is iron deficiency and is usually caused by low iron stores prior to pregnancy⁵. The results of this study are in agreement with a study in Nigeria which reported that pregnant women in rural areas had a significantly higher median STfR than those in urban areas¹⁸. Interestingly, the median Hb level of pregnant women in rural areas in the present study was only slightly lower than that in urban areas, suggesting STfR levels may be a better indicator of iron status. Similar results were found in studies of healthy women in India¹⁹ as well as pregnant women in Tibet²⁰.

The current results also showed that differences in STfR and Hb levels between rural and urban areas were directly influenced by nutritional intake, particularly iron. Adequate intake of iron in pregnant women with IDA had a significant effect on STfR levels. A previous study reported that anemic pregnant women who consumed at least 60 mg d⁻¹ of iron for 100 d since 19 weeks of pregnancy, were able to increase their Hb levels and such supplementation was also shown to

increase iron reserves in non-anemic pregnant women²¹. In the present study, the iron intake of pregnant women in rural areas was much lower than those in urban areas. Similar results were found in China, wherein pregnant women in urban areas consumed more animal-based and diverse foods compared to pregnant women in rural areas²². This could easily explain the low Hb and high STfR levels of pregnant women in rural areas in the present study and others.

In rural areas of developing countries, people more often consume food from plant sources rather than animal. Temanggung Regency is an agricultural and plantation area, which allows inhabitants to consume more self-grown plant-based food, whereas those living in Semarang City must buy food in the marketplace, which provides greater dietary variety. Animal-based food is a main source of more readily absorbable heme iron compared to non-heme iron from plant sources. A study in Pakistan reported that consumption of red meat less than twice a week before pregnancy was associated with decreased Hb levels during pregnancy²³. Plant-based foods, such as wheat, nuts and vegetables, contain high levels of fiber (e.g., phytic, tannic and chlorogenic acids) that can inhibit the absorption of non-heme iron²⁴.

Lack of animal-based food consumption, especially in rural areas, is also affected by a lower intake of vitamin B12, commonly known as cobalamin. Vitamin B12 deficiency in pregnant women can cause recurrent abortion, infertility and preterm abortion. Vitamin B12 along with folic acid play a key role in the formation of red blood cells; hence, a deficiency of vitamin B12 has been shown to be the second most common cause of megaloblastic anemia²⁵. An unbalanced vegetarian diet leads to certain nutritional deficiencies since plant-based foods have lower bioavailability of certain vitamins and minerals. However, because vitamin B12 is relatively absent from plant-based food, it must be supplied to the body through alternative sources²⁶. In the present study, intake

of vitamin B12 in rural areas was lower ($1.5 \mu\text{g day}^{-1}$) than the value recommended by the Ministry of Health of Indonesia ($2.6 \mu\text{g day}^{-1}$) for pregnant women in their third trimester²⁷. Furthermore, consumption of a largely plant-based diet by pregnant women in rural areas of Central Java was related to an increased risk of vitamin B12 deficiency and, therefore, anemia.

The current results also revealed that the types and sources of food consumed was closely related to socioeconomic status. A previous study in Ethiopia found that pregnant women with a lower household socioeconomic status had a significantly higher prevalence of anemia than those from a higher socioeconomic status²⁸. Likewise, the current results showed the family income of pregnant women living in urban areas was twice as high as those from rural areas and was associated with better food intake. This is most likely because households with a higher socioeconomic status are able to allocate more of their budget towards food, in terms of both quantity and quality²⁹. Moreover, people living in urban areas with a high income level more often consume animal-based foods³⁰. Thus, the risk of anemia in pregnant women from lower socioeconomic families has been estimated to be 1.6-times higher than that of the pregnant women from higher socioeconomic families³¹.

Based on the behavioral theory of Lawrence Green, healthy behavior can be formed when preceded by predisposing factors, one being knowledge. Adequate health knowledge supported by strong motivation can encourage personal health action³². Pregnant women with good nutritional knowledge are more likely to eat more nutritious foods during pregnancy. Additionally, knowledge level is influenced by education level/duration³³. A study in Malaysia found that education level was significantly associated with anemia during pregnancy³⁴. The majority of mothers in that study with a higher education level were more concerned about their personal and fetal health³⁴. A literature review showed that 49% of college graduates obtained useful health information from books, newspapers and/or magazines compared to 18% of the less educated. Moreover, a study in Sudan indicated that women with a higher education level were less frequently anemic than illiterate women or women with only a primary or secondary education³⁵. In rural Central Java, most pregnant women are poorly educated, leading to the assumption that their level of knowledge is also lower than that of pregnant women in urban areas. A significant difference in knowledge level has been reported to be caused by a lack of awareness regarding the consequences of inadequate nutrition during pregnancy³⁶.

This conclusion is also supported by the findings of a US study showing the chances of anemia during pregnancy declined as the education level of the mother increased³⁷.

CONCLUSION

The results of the present study indicated that the incidence of maternal anemia differs depending on rural or urban residential location in Central Java, Indonesia. This result was due to differences in education, culture, habits and environmental factors affecting behavior and diet. Pregnant women in rural areas should consume more varied foods and increase the consumption of animal-based food or supplements to improve iron status during pregnancy.

SIGNIFICANCE STATEMENT

This study investigated the differences in hemoglobin and serum transferrin receptor levels in pregnant woman residing in rural and urban areas of Central Java, Indonesia. The results help uncover critical areas and people groups at greater risk of tissue iron deficiency in developing countries as well as factors influencing iron status. Furthermore, measurement of serum transferrin receptor levels is shown to be a better measure of early iron status and anemia risk.

ACKNOWLEDGMENTS

The authors thank the Directorate General of Public Health, Ministry of Health, Republic of Indonesia and Faculty of Public Health of Diponegoro University which facilitated and funded this research. We also thank Nur Asiah Rahmi, Rizky Arum, Misrina Ulil Aziza, Hani Novita Sari Pratiwi, Ella Febriana and Dianissa Fitrah Hidayati for their contribution as the enumerators of this study.

REFERENCES

1. Stevens, G.A., M.M. Finucane, L.M. De-Regil, C.J. Paciorek and S.R. Flaxman *et al.*, 2013. Global, regional and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995-2011: A systematic analysis of population-representative data. *Lancet Global Health*, 1: e16-e25.
2. Karimzaei, T., I. Zareban, A.Q. Jamalzaei, F. Darban, K.D. Bakhshani and A. Balouchi, 2016. Frequency of maternal mortality in urban and rural areas of Iranshahr county (Southeast of Iran) in 2009-2013: A retrospective study. *J. Clin. Diagn. Res.*, 10: QC14-QC17.

3. McMahon, L.P., 2010. Iron deficiency in pregnancy. *Obstet. Med.*, 3: 17-24.
4. Chowdhury, S., M. Rahman and A. Moniruddin, 2014. Anemia in pregnancy. *Med. Today*, 26: 49-52.
5. Mei, Z., M.E. Cogswell, A.C. Looker, C.M. Pfeiffer, S.E. Cusick, D.A. Lacher and L.M. Grummer-Strawn, 2011. Assessment of iron status in US pregnant women from the National Health and Nutrition Examination Survey (NHANES), 1999-2006. *Am. J. Clin. Nutr.*, 93: 1312-1320.
6. Ministry of Health Republic of Indonesia, 2013. Indonesian Health Profile 2013. Ministry of Health Republic of Indonesia, Jakarta, pp: 1-180.
7. Ministry of Health Republic of Indonesia, 2016. Indonesian Health Profile 2016. Ministry of Health Republic of Indonesia, Jakarta, pp: 1-220.
8. Atif, M., M.A. Ansari, Z. Khan and A. Ahmad, 2017. Nutritional status of adolescent boys in urban and rural Aligarh, Uttar Pradesh, India. *Int. J. Commun. Med. Public Health*, 3: 852-855.
9. Yi, B., L. Wu, H. Liu, W. Fang, Y. Hu and Y. Wang, 2011. Rural-urban differences of neonatal mortality in a poorly developed province of China. *BMC Public Health*, Vol. 11, No. 1. 10.1186/1471-2458-11-477
10. Genowska, A., M. Zalewska, J. Jamiolkowski, U. Stepniak, A. Szpak, E. Maciorkowska and J. Pinkas, 2016. Inequalities in mortality of infants under one year of age according to foetal causes and maternal age in rural and urban areas in Poland, 2004-2013. *Ann. Agric. Environ. Med.*, 23: 285-291.
11. Shafique, S., N. Akhter, G. Stallkamp, S. de Pee, D. Panagides and M.W. Bloem, 2007. Trends of under-and overweight among rural and urban poor women indicate the double burden of malnutrition in Bangladesh. *Int. J. Epidemiol.*, 36: 449-457.
12. Jain, S., S. Narayan, J. Chandra, S. Sharma, S. Jain and 42. Talhan, 2010. Evaluation of serum transferrin receptor and sTfR ferritin indices in diagnosing and differentiating iron deficiency anemia from anemia of chronic disease. *Indian J. Pediatr.*, 77: 179-183.
13. Infusino, I., F. Braga, A. Dolci and M. Panteghini, 2012. Soluble transferrin receptor (sTfR) and sTfR/log ferritin index for the diagnosis of iron-deficiency anemia a meta-analysis. *Am. J. Clin. Pathol.*, 138: 642-649.
14. Semarang Distric Health Office, 2015. Health profile of Semarang city. Semarang Distric Health Office, Semarang.
15. Temanggung Distric Health Office, 2015. Health profile of Temanggung regency. Temanggung Distric Health Office, Temanggung.
16. WHO., 2011. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. World Health Organization, Geneva, pp: 1-6.
17. Khambalia, A.Z., C.E. Collins, C.L. Roberts, J.M. Morris, K.L. Powell, V. Tasevski and N. Nassar, 2016. Iron deficiency in early pregnancy using serum ferritin and soluble transferrin receptor concentrations are associated with pregnancy and birth outcomes. *Eur. J. Clin. Nutr.*, 70: 358-363.
18. Okafor, I.M., D.C. Okpokam, A.B. Antai and E.A. Usanga, 2016. Iron status of pregnant women in rural and urban communities of Cross River State, South-South Nigeria. *Niger. J. Physiol. Sci.*, 31: 121-125.
19. Kaur, M. and G.K. Kochar, 2009. Burden of anaemia in rural and urban jat women in Haryana state, India. *Malays. J. Nutr.*, 15: 175-184.
20. Xing, Y., H. Yan, S. Dang, B. Zhuoma, X. Zhou and D. Wang, 2009. Hemoglobin levels and anemia evaluation during pregnancy in the highlands of Tibet: A hospital-based study. *BMC Public Health*, Vol. 9, No. 1. 10.1186/1471-2458-9-336
21. Nair, K.M., P. Bhaskaram, N. Balakrishna, P. Ravinder and B. Sesikeran, 2004. Response of hemoglobin, serum ferritin and serum transferrin receptor during iron supplementation in pregnancy: A prospective study. *Nutrition*, 20: 896-899.
22. Gao, H., C. Stiller, V. Scherbaum, H. Biesalski, Q. Wang, E. Hormann and A. Bellows, 2013. Dietary intake and food habits of pregnant women residing in urban and rural areas of Deyang city, Sichuan province, China. *Nutrients*, 5: 2933-2954.
23. Baig-Ansari, N., S.H. Badruddin, R. Karmaliani, H. Harris and I. Jehan *et al.*, 2008. Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan. *Food Nutr. Bull.*, 29: 132-139.
24. Hunt, J.R., 2003. Bioavailability of iron, zinc and other trace minerals from vegetarian diets. *Am. J. Clin. Nutr.*, 78: 633S-639S.
25. Bhardwaj, A., D. Kumar, S.K. Raina, P. Bansal, S. Bhushan and V. Chander, 2013. Rapid assessment for coexistence of vitamin B12 and iron deficiency anemia among adolescent males and females in Northern Himalayan state of India. *Anemia*, Vol. 2013. 10.1155/2013/959605
26. Rizzo, G., A. Lagana, A. Rapisarda, G. La Ferrera and M. Buscema *et al.*, 2016. Vitamin B12 among vegetarians: Status, assessment and supplementation. *Nutrients*, Vol. 8, No. 12. 10.3390/nu8120767
27. Ministry of Health Republic of Indonesia, 2013. Regulation of ministry of health republic of Indonesia No. 75 year 2013 about Indonesian nutritional adequacy. Ministry of Health Republic of Indonesia, Jakarta.
28. Lebso, M., A. Anato and E. Loha, 2017. Prevalence of anemia and associated factors among pregnant women in Southern Ethiopia: A community based cross-sectional study. *PloS One*, Vol. 12, No. 12. 10.1371/journal.pone.0188783
29. French, S.A., M. Wall and N.R. Mitchell, 2010. Household income differences in food sources and food items purchased. *Int. J. Behav. Nutr. Phys. Activity*, Vol. 7, No. 1.

30. Vlismas, K., V. Stavrinou and D.B. Panagiotakos, 2009. Socio-economic status, dietary habits and health-related outcomes in various parts of the world: A review. *Central Eur. J. Public Health*, 17: 55-63.
31. Karaoglu, L., E. Pehlivan, M. Egri, C. Deprem, G. Gunes, M.F. Genc and I. Temel, 2010. The prevalence of nutritional anemia in pregnancy in an east Anatolian province, Turkey. *BMC Public Health*, Vol. 10, 10.1186/1471-2458-10-329
32. Green, L.W., M.W. Kreuter, S.G. Deeds and K.B. Partridge, 1980. *Health Education Planning: A Diagnostic Approach*. 1st Edn., Mayfield Publishing Company, Palo Alto.
33. Silles, M.A., 2009. The causal effect of education on health: Evidence from the United Kingdom. *Econ. Educ. Rev.*, 28: 122-128.
34. Soh, K.L., E.R.M. Tohit, S. Japar, S.K. Geok, N.B. Ab Rahman and R.A. Raman, 2015. Anemia among antenatal mother in Urban Malaysia. *J. Biosci. Med.*, 3: 6-11.
35. Morsy, N. and S. Alhady, 2014. Nutritional status and socio-economic conditions influencing prevalence of anaemia in pregnant women. *Int. J. Scient. Technol. Res.*, 3: 54-60.
36. Payghan, B.S., S.S. Kadam and R.M. Reddy, 2014. A comparative study of nutritional awareness among urban-rural pregnant mothers. *Res. Rev. J. Med. Health Sci.*, 3: 95-99.
37. Adebisi, O.Y. and G. Strayhorn, 2005. Anemia in pregnancy and race in the United States: Blacks at risk. *Fam. Med.*, 37: 655-662.

Hemoglobin and Serum Transferrin Receptor Differences in Pregnant Women in Rural and Urban Areas of Central Java Province, Indonesia

ORIGINALITY REPORT

18%

SIMILARITY INDEX

10%

INTERNET SOURCES

14%

PUBLICATIONS

5%

STUDENT PAPERS

PRIMARY SOURCES

- 1

Siekman, Kendra, Olivier Receveur, and Slim Haddad. "Can an Integrated Approach Reduce Child Vulnerability to Anaemia? Evidence from Three African Countries", PLoS ONE, 2014.

1%

Publication
 - 2

Zhou, B., K. Chen, J. Wang, H. Wang, S. Zhang, and W. Zheng. "Quality of Life and Related Factors in the Older Rural and Urban Chinese Populations in Zhejiang Province", Journal of Applied Gerontology, 2011.

1%

Publication
 - 3

Melda Kangalgil, Ayhan Sahinler, Lecturer Ilknur Buçan Kirkbir, Prof. Dr. Ayşe Özfer Özçelik. "Associations of Maternal Characteristics and Dietary Factors with Anemia and Iron-Deficiency in Pregnancy", Journal of Gynecology Obstetrics and Human Reproduction, 2021

1%

Publication
-

4

Hetty Ismainar, Hertanto W Subagio,
Bagoes Widjanarko, Cahyono Hadi. "

1 %

To What Extent Do Ecological Factors of
Behavior Contribute to the Compliance of
the Antenatal Care Program in Dumai City,
Indonesia?

", Risk Management and Healthcare Policy,
2020

Publication

5

Salma Chowdhury, Mizanur Rahman, ABM
Moniruddin. "Anemia in Pregnancy",
Medicine Today, 2014

1 %

Publication

6

Meng Lee Tan, Yit Siew Chin, Poh Ying Lim,
Salma Faeza Ahmad Fuzi. "Associations of
obstetrical characteristics and dietary
intakes with iron status among pregnant
women in Selangor and Kuala Lumpur",
British Food Journal, 2020

1 %

Publication

7

Mujahed I. Mustafa, Abdelrahman H.
Abdelmoneim, Nafisa M. Elfadol, Soada A.
osman, Tebyan A. Abdelhameed, Mohamed
A. Hassan. " Novel PRSS1 Gene that could
potentially cause hereditary pancreatitis:
Using Comprehensive in silico Approach ",
Cold Spring Harbor Laboratory, 2019

1 %

Publication

8	Submitted to National postgraduate Medical College of Nigeria Student Paper	1 %
9	jfmipc.com Internet Source	1 %
10	www.thefreelibrary.com Internet Source	1 %
11	id.123dok.com Internet Source	<1 %
12	pubmed.ncbi.nlm.nih.gov Internet Source	<1 %
13	Yuan-duo Zhu, Bei-bei Zhu, Hui Gao, Kun Huang et al. "Repeated measures of prenatal phthalate exposure and maternal hemoglobin concentration trends: The Ma'anshan birth cohort (MABC) study", Environmental Pollution, 2018 Publication	<1 %
14	www.neliti.com Internet Source	<1 %
15	Ciro Avitabile, Tullio Jappelli, Mario Padula. "Cognitive Abilities, Healthcare and Screening Tests", Journal of Population Ageing, 2011 Publication	<1 %
16	Submitted to Higher Education Commission Pakistan Student Paper	<1 %

17 Jun Zhao, Xiaoyue Zhu, Qiaoyun Dai, Xiang Hong et al. "The prevalence and influencing factors of anemia among pre-pregnant women in mainland China: A large population-based, cross-sectional study", British Journal of Nutrition, 2021
Publication

18 S K An. "To discard or not to discard: the neural basis of hoarding symptoms in obsessive-compulsive disorder", Molecular Psychiatry, 03/2009
Publication

19 Submitted to University of Westminster
Student Paper

20 "Pregnant women in poor countries face domestic violence", BMJ, 11/26/2005
Publication

21 Azmat Ullah, Muhammad Sohaib, Farhan Saeed, Sanaullah Iqbal. "Prevalence of anemia and associated risk factors among pregnant women in Lahore, Pakistan", Women & Health, 2018
Publication

22 jsi.com
Internet Source

23 sites.google.com
Internet Source

24 Oya Halicioglu, Sumer Sutcuoglu, Feyza Koc, Can Ozturk, Esin Albudak, Ayfer Colak, Ebru Sahin, Sezin Asik Akman. " Vitamin B and folate statuses are associated with diet in pregnant women, but not with anthropometric measurements in term newborns ", The Journal of Maternal-Fetal & Neonatal Medicine, 2012

Publication

<1 %

25 www.biomedcentral.com

Internet Source

<1 %

26 www.tandfonline.com

Internet Source

<1 %

27 "OSTEOARTHRITIS ? CLINICAL ASPECTS",
APLAR Journal of Rheumatology, 8/2006

Publication

<1 %

28 Emeir M Duffy. "Iron status in pregnant women in the Republic of Seychelles", Public Health Nutrition, 08/26/2009

Publication

<1 %

29 Fengji Geng, Xiaoqin Mai, Jianying Zhan, Lin Xu, Zhengyan Zhao, Michael Georgieff, Jie Shao, Betsy Lozoff. "Impact of Fetal- Neonatal Iron Deficiency on Recognition Memory at 2 Months of Age", The Journal of Pediatrics, 2015

Publication

<1 %

30 Gedefaw, L, A Ayele, Y Asres, and A Mossie. "Anaemia and associated factors among

<1 %

pregnant women attending antenatal care clinic in Walayita Sodo town, Southern Ethiopia", Ethiopian Journal of Health Sciences, 2015.

Publication

-
- 31 Kimitoshi Imai. "Parity-based assessment of anemia and iron deficiency in pregnant women", Taiwanese Journal of Obstetrics and Gynecology, 2020

<1 %

Publication

-
- 32 Yutaka Kohgo, Yoshihiro Torimoto, Junji Kato. "Transferrin Receptor in Tissue and Serum: Updated Clinical Significance of Soluble Receptor", International Journal of Hematology, 2002

<1 %

Publication

-
- 33 archive.org

Internet Source

<1 %

-
- 34 ueaeprints.uea.ac.uk

Internet Source

<1 %

-
- 35 "Chemoprevention of Cancer and DNA Damage by Dietary Factors", Wiley, 2009

<1 %

Publication

-
- 36 Anna Galindo, Daniel Bodri, Juan José Guillén, Marta Colodrón, Valérie Vernaève, Oriol Coll. "Triggering with HCG or GnRH agonist in GnRH antagonist treated oocyte donation cycles: a randomised clinical trial", Gynecological Endocrinology, 2009

<1 %

Publication

37

Ashok Bhardwaj, Dinesh Kumar, Sunil Kumar Raina, Pardeep Bansal, Satya Bhushan, Vishav Chander. "Rapid Assessment for Coexistence of Vitamin B12 and Iron Deficiency Anemia among Adolescent Males and Females in Northern Himalayan State of India", *Anemia*, 2013

Publication

<1 %

38

Enko, Dietmar, Helga Wagner, Gernot Kriegshäuser, Christine Kimbacher, Robert Stolba, and Gabriele Halwachs-Baumann. "Assessment of human iron status: A cross-sectional study comparing the clinical utility of different laboratory biomarkers and definitions of iron deficiency in daily practice", *Clinical Biochemistry*, 2015.

Publication

<1 %

39

Lei Jin, Lorraine F Yeung, Mary E Cogswell, Rongwei Ye, Robert J Berry, Jianmeng Liu, Dale J Hu, Li Zhu. "Prevalence of anaemia among pregnant women in south-east China, 1993–2005", *Public Health Nutrition*, 2010

Publication

<1 %

40

R. Leoncini, D. Vannoni, R. Guerranti, G. Cinci, A. Tabucchi, F. Carlucci, E. Marinello, A. B. Agostinho. "Serum Folate and Vitamin B12 Levels in Children from Mozambique", *Nucleosides, Nucleotides and Nucleic Acids*, 2004

<1 %

- 41

Yijun Kang, Shaonong Dang, Lingxia Zeng, Duolao Wang, Qiang Li, Jianpeng Wang, Luobu Ouzhu, Hong Yan. "Multi-micronutrient supplementation during pregnancy for prevention of maternal anaemia and adverse birth outcomes in a high-altitude area: a prospective cohort study in rural Tibet of China", British Journal of Nutrition, 2017

Publication

<1 %
- 42

benthamopen.com

Internet Source

<1 %
- 43

documents.mx

Internet Source

<1 %
- 44

natureglow.com.au

Internet Source

<1 %
- 45

onlinelibrary.wiley.com

Internet Source

<1 %
- 46

pdfs.semanticscholar.org

Internet Source

<1 %
- 47

www.fao.org

Internet Source

<1 %
- 48

"Handbook of Nutrition and Pregnancy", Springer Science and Business Media LLC, 2008

Publication

<1 %

49

Jemal A Haidar. "Iron deficiency anemia is not a rare problem among women of reproductive ages in Ethiopia: a community based cross sectional study.", BMC Blood Disorders, 2009

Publication

<1 %

50

N. Lombard-Vignon, C. Lafuma, G. Godeau, R. Masse. "Early Modifications of Outgrowth and Metallo-endopeptidase Activity in Fibroblasts from Rat Cutaneous Explants after Local γ -irradiation: Dermis Cellularity and Collagen Fibre Alterations", International Journal of Radiation Biology, 2009

Publication

<1 %

Exclude quotes Off

Exclude matches Off

Exclude bibliography On