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Effectivity of Iron Supplementation With and Without Vitamin C for Increasing Hemoglobin Levels Among Women Aged 16-21 Years Old

Jessica Lauryn[1], Freggy S. Joprang[2], Angela Kurniadi[3], Leonardo[1,2], Fransiskus Xaverius Rinaldi[1], Erlina[1], Gregorio Gavriel Singgih[1]

[1]Faculty of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia
[2]Department of Parasitology, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia
[3]Department of Nutrition, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia
E-mail: jessicalauryn97@gmail.com

Abstract

Anemia can be caused by a decrease in hemoglobin (Hb) levels, chronic disease, severe bleeding, nutritional deficiency, and infectious diseases. Iron deficiency is the most common cause of anemia (50%). Vitamin C has an important role in increasing absorption of iron in the body which can indirectly affect the increase in Hb formation. This study was conducted to determine whether iron and vitamin C supplementation affect the changes of Hb levels in women. This study was done by quasi experimental with single blind pretest posttest control group and with a stratified random sampling technique. Respondents were female students in Faculty of Medicine UNIKA Atma Jaya. The total number of sample was 58 which was categorized into two groups. The first group was given iron and vitamin C supplementation. The second was only given iron supplementation. There were 16 respondents (27,6%) aged 16-18 and 42 respondents (72,4%) aged 19-21. The average change in Hb level before and after intervention in group 1 was 1,934 g/dL, and P = 0,000 (P <0,05), the average change in Hb level before and after intervention in group 2 was 1,086 g/dL, and P = 0,000 (P <0,05). The difference of change in Hb levels in groups 1 and 2 had an average of 0,848 g/dL, and P = 0,005 (P <0,05). For conclusion, Iron and vitamin C supplementation has a greater impact on the changes of Hb levels compared to iron supplementation only.

Keywords: Hemoglobin, Iron Deficiency Anemia, Iron Supplementation, Vitamin C.

1. Introduction

Anemia is a global health problem that occurs both in developed and developing countries. In 2011, according to WHO, South East Asia was the region with the lowest average hemoglobin concentration (Hb) and the second highest prevalence of anemia (58,3%) after Africa (62,3%).[1] Based on RISKESDAS (Riset Kesehatan Dasar) in 2013, the prevalence of anemia in Indonesia was 21,7%, with the proportion of 20,6% in urban areas and 22,8% in rural areas and 18,4% in men and 23,9% in women. Based on age group, patients with anemia aged 5-14 years were 26,4% and 18,4% were in the age group 15-24 years.[2] Based on data from the WHO (World Health Organization) in 2011, 29% of women of reproductive age experienced anemia, 38% of cases occur in pregnant women, and 29% in women who are not pregnant.[1]

Anemia can be caused by a lack of protein compounds that form erythrocytes or red blood cells, one of which is Hb. In addition, anemia can be caused by chronic disease, heavy bleeding, anemia due to low vitamin or mineral forming Hb (deficiency anemia), and anemia caused by infectious diseases. Of all the causes of anemia that exist, 50% of the causes that often occur are anemia due to iron deficiency.[3-5,9] Anemia due to iron deficiency (Fe) is one of the main nutritional problems in Asia, including in Indonesia. Iron deficiency can occur due to lack of nutritional intake or failure of the absorption of iron in the body so that it affects the decrease in the formation of Hb.[6] Women in their productive age have a high risk of suffering from iron deficiency anemia due to the large amount of blood loss during the menstrual phase.[4]

Vitamin C can increase the absorption of iron in the body which indirectly affects the increase in the formation of Hb.[9] In 2007, the University of Diponegoro (UNDIP) conducted a study by comparing Hb levels before and after the study in elementary school children. The group that was given iron supplements, vitamin C, and education about nutrition, had a higher increase of Hb level compared to the group that was given iron and vitamin C supplements or the group that was given iron supplementation and education only.[7] Bogor Agricultural University (IPB) also conducted research in 2016 in adolescent girls by giving iron supplements on a weekly basis, their research showed an increased Hb levels in each group.[8] Another study in 2017 was conducted on iron supplementation for pregnant women at Public Health Center in Kediri City. This study found an increase in Hb levels in 85,3% of respondents by giving iron supplements at the 12th week of pregnancy which was then continued until 3 months postpartum.

Based on the things above, the authors are interested in exploring more about the effectiveness of giving iron supplements with and without additional vitamin C to increase hemoglobin levels in women aged 16-21 years.

2. Method

The method used in this study is a quasi-experimental design with a single blind pretest posttest control group and a stratified random sampling technique that was conducted at the Faculty of Medicine, Atma Jaya Catholic University of Indonesia on August-October 2018. In this study, there were 2 treatment groups: the group with administration of iron supplements and vitamin C, and the group with iron supplements without vitamin C.

The inclusion criteria for this study were female students of the Faculty of Medicine, Atma Jaya Catholic University of Indonesia aged 16-21 years who were not taking vitamin C, iron, or other drugs, and were not diagnosed with iron deficiency anemia. The

exclusion criteria in this study were respondents who had allergies to iron supplements and vitamin C. The drop out criteria were respondents who experienced severe side effects to iron supplements and vitamin C during the study (e.g. diarrhea, constipation, abdominal pain, nausea, vomiting, loss of appetite), respondents who experienced allergic reactions to iron supplements and vitamin C, and respondents who were sick at the time of the study that had to take other drugs.

The study was conducted at Faculty of Medicine, Atma Jaya Catholic University of Indonesia with a total of 29 respondents in each group. First, measurements of Hb levels were carried out before the intervention using an Hb meter, then respondents were given vitamin C and iron supplements or iron alone every week for 12 weeks and consumed 2 times a week on the specified day. The respondents were given ferrous sulfate 325 mg (iron 65 mg) and vitamin C 75 mg. The group that did not receive vitamin C (group 2) will be given a placebo (sugar pill). After 12 weeks, measurement of Hb levels after the intervention using an Hb meter was carried out and then the data analysis and discussion were carried out to find whether there were differences in Hb levels before and after the intervention in each group using a T-test dependent and comparing Hb levels after the intervention between two groups with the independent T-test.

3. Results

In this study, there were 16 respondents (27,6%) aged 16-18 years and 42 respondents (72,4%) aged 19-21 years. There were 58 respondents that consist of 3 batches (2015, 2016, 2017) with 36,2%, 29,3%, and 34,5% each.

The Hb level in group 1 before being given iron supplementation and vitamin C had an average value of 12,482 g/dL, while the Hb level in this group after the intervention had an average value of 14,417 g/dL. Hb levels before and after the intervention in this group obtained the average value of the difference is 1,934 g/dL. We also calculated the maximum and minimum changes in Hb levels before and after the intervention on the same respondent, with each result are 4,100 g/dL and 0,300 g/dL. The Hb levels in group 2 before being given iron supplements had an average value of 12,372 g/dL, while the Hb level in this group after the intervention had an average value of 13,458 g/dL. Hb levels before and after intervention in this group were calculated the difference and the average value of the difference was 1,086 g/dL. For the maximum and minimum changes in Hb levels before and after the intervention on the same respondent, with each result are 2,900 g/dL and 0,200 g/dL.

Table 1. Demographic Characteristics

Variable		n	Percent (%)
Age	16-18 yrs	16	27,6
	19-21 yrs	42	72,4
	Total	58	100
Batch	2015	21	36,2
	2016	17	29,3
	2017	20	34,5
	Total	58	100

Table 2. Average Value, Max Value, Minimal value of Hb Levels Before and After Intervention in Group 1 (Iron and Vitamin C Supplements)

	Before	After	Differences
Average (g/dL)	12,482	14,417	1,934
Max (g/dL)			4,100
Min (g/dL)			0,300

Table 3. Average Value, Max Value, Minimal value of Hb Levels Before and After Intervention in Group 2 (Iron Supplements)

	Before	After	Differences
Average (g/dL)	12,372	13,458	1,086
Max (g/dL)			2,900
Min (g/dL)			0,200

The difference of Hb levels before and after the intervention in group 1 (iron and vitamin C supplement) was carried out by a T-test dependent, it was found that the average change in Hb levels before and after the intervention was 1,934, and P=0,000. The probability shows P <0,05 which means the change in Hb levels before and after the intervention is significant. The difference in Hb levels before and after the intervention in group 2 (iron supplement) was also tested by a T-test dependent. In this test, the average value of the difference in Hb levels before and after the intervention was 1,086 g/dL, and P=0,000. The probability shows P <0.05 which means there is a significant difference in Hb levels between before and after the intervention.

Table 4. Significance of Differences in Hemoglobin Levels with Dependent T-test in Group 1 and Group 2

	T-Test Dependent		Description
	Group 1	Group 2	P < 0,05 each group before and after intervention means a significant difference
Mean (g/dL)	1,934	1,086	
P value	0,000	0,000	

The difference in Hb levels in group 1 (iron and vitamin C supplement) and group 2 (iron supplement) was tested by Independent T-test. In this test, the average value of the difference in Hb levels in groups 1 and 2 was 0,848 g/dL, and P=0,005. The probability shows P <0,05 which means that there is a significant difference in Hb levels between before and after the intervention in group 1 and group 2.

Table 5. Significance of Differences in Hemoglobin Levels with Independent T-test in Group 1 and Group 2

	T-Test Independent	Description
Difference Mean (g/dL)	0,848	P <0,05 means the difference in the mean of group 1 and 2 is significant
P value	0,005	

4. Discussion

According to data from RISKESDAS (Basic Health Research) in 2013, the prevalence of anemia in Indonesia is 18.4% for men and 23.9% for women.[2] Adolescents have a high risk of anemia, especially iron deficiency anemia (IDA). This happens because adolescence requires higher nutrients including iron for growth and development. Young women have a higher risk than young men, because of menstruation every month.[10,11] Thus, this study was conducted on young women, especially those aged 16-21 years at the Faculty of Medicine, Atma Jaya Catholic University of Indonesia

Iron is an important mineral needed to carry out various body metabolisms including the production of hemoglobin which transports oxygen to all body tissues.[12] The process of iron absorption is influenced by several factors such as organic acids that help iron absorption, compounds that inhibit iron absorption, the body's need for iron, as well as high levels of gastric acidity which can increase the solubility of iron. Phytic acid found in cereal fiber, oxalic acid in vegetables, tannins which are polyphenols found in tea, coffee, and some types of vegetables and fruits will inhibit iron absorption. This is because phytic acid and oxalic acid bind to iron so that the absorption process is inhibited. Thus, even though the iron content in cereals and vegetables is high, the

absorption of iron from these food sources is less.[13] Meanwhile, Vitamin C or ascorbic acid as an organic acid can help increase the absorption of iron. The level of gastric acidity can affect the solubility and iron absorption, thus iron supplements are better taken before meals so that the effectiveness of iron absorption increases.

Iron supplementation can be used to increase Hb levels in IDA, and prevent the occurrence of IDA. Based on the recommendations from Ikatan Dokter Anak Indonesia (IDAI) regarding iron supplementation for children in 2011, iron supplementation in adolescent boys and girls is given at a dose of 60 mg/day for 3 months. Intermittent administration of iron supplementation with a dose of 60 mg/day has been shown to increase Hb levels.[14]

Changes in Hb levels in this study increased in both groups after both were given iron supplements. The changes that occurred were proven to be significant with the average difference in Hb levels of each group before and after the intervention. In group 1, the changes in Hb levels obtained were 1.934 g/dL and 1.086 g/dL in group 2.

An increase in Hb levels also occurred in a study conducted on adolescent girls in Bogor, 2017, which was 0.890 g/dL. The success of this study was also expressed in the reduction in the prevalence of anemia from 20.7% to 15.2%.[15] The increase in Hb levels after iron supplementation in both intervention groups of the two studies showed the effectiveness of iron supplementation for the treatment of deficiency anemia as well as for prevention. As for this study, which was conducted in Bogor, 60 mg of iron supplementation was carried out for four months (2 times a week) and ten tablets daily during menstruation.[14] This study was also carried out the study in Bogor for adolescent girls, which the iron supplementation was given as much as 65 mg for 12 weeks (2 times a week) according to IDAI recommendations. However, iron supplements were not given during menstruation. Based on research conducted at IPB in 2016 for 14 weeks, no significant different of increasing in Hb level between group were given iron supplements every day during menstruation with those not given.[8]

Vitamin C has function in forming substances between cells and various tissues and increases the body's resistance by the phagocytic activity of white blood cells and transport of iron from transferrin in the blood to ferritin in the bone marrow liver, and spleen. In addition, Vitamin C can increase Hb levels by increasing iron absorption.

In this study, there was a significant difference in Hb levels between the groups given iron and vitamin C supplementation with iron supplementation alone, where the average value of changes in Hb levels was higher in the intervention group that added vitamin C, the average difference value. is 0.848 g/dL. This shows that iron absorption increases with the consumption of vitamin C compared to those who only consume iron supplements.

The same thing happened in a study conducted in India in 2006. The study was conducted for 100 days on non-pregnant women suffering from iron deficiency anemia (aged 15-55 years) and divided into three groups, the group taking iron supplements (200 mg) and folic acid (0.5 mg), the group taking iron supplements (200 mg), folic acid (0.5 mg), and vitamin C (100 mg) and the control group. All of these supplements are taken daily. A significant increase in Hb levels occurred after taking supplements every day in the group with iron and folic acid supplementation, 2.72 g/dL, and in the group supplemented with vitamin C, which was 4.36 g/dL. Thus, it can be calculated that the average difference in Hb levels from the two groups is 1.64 g/dL and shows a significant change in Hb levels when added with vitamin

C consumption. Meanwhile, the control group or the group that was not given any intervention showed no significant changes of Hb levels.[17] Another study was conducted on 6th-grade students of SDN Klego 01 Pekalongan City in 2010, which examined the effect of giving iron supplements (200 mg) and vitamin C (50 mg) and giving iron supplements alone (200 mg) on changes in Hb levels. Consumption of supplements is done two times a week for three weeks. The results of the comparison of the difference in the average Hb levels obtained were significant, 1.6 g/dL in the group that added vitamin C consumption.[18] The similarity of this study with research conducted in India and in Pekalongan is the addition of vitamin C to iron can increase Hb levels higher than the group not given vitamin C. In this study, vitamin C was consumed after iron supplementation, two times a week, which was also carried out in a study in Pekalongan City, while in a study in India, it was consumed every day. Day. However, the difference in the time of giving vitamin C did not give different results.[19]

5. Conclusion

Based on the experiment results, it can be concluded that there is significant increase of hemoglobin levels after supplementation of iron and vitamin C from the first subject population (Group 1), and a significant improvement of hemoglobin level in the second subject population that only receives iron supplementation (Group 2). Between the first and the latter there is a remarkable difference in the increase of the hemoglobin level.

There are many factors including folic acid, vitamin B12, iron rich food or even diets that interfere with iron absorption could play a role in hemoglobin levels. Further experiment is needed tot assess these factors that may contribute to hemoglobin level rise.

References

1. WHO | The global prevalence of anaemia in 2011 [Internet]. WHO. [cited 2017 May 19]. Available from:http://www.who.int/entity/nutrition/publications/micronutrients/global_prevalence_anaemia_2011/en/index.html
2. Puslitbangkes. Riset Kesehatan Dasar 2013. Jakarta: Kementerian Kesehatan Republik Indonesia. 2013.
3. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F etal. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnanst and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. Lancet Glob Health. 2013;1:E16–E25.
4. WHO/UNICEF/UNU. Iron deficiency anaemia assessment, prevention, and control: a guide for programme managers in 2001 [Internet]. Geneva, World Health Organization [cited 2017 May 19] Available from: http://www.who.int/nutrition/publications/en/ida_assessment_prevention_control.pdf.
5. Guideline: Intermittent iron and folic acid supplementation in menstruating women. Geneva: World Health Organization; 2011(http://apps.who.int/iris/bitstream/10665/44649/1/9789241502023_eng.pdf?ua=1, accessed 22 May 2017).
6. Tee ES. Priority nutritional concerns in Asia. Food and Nutrition Bulletin. 2002;23: 345-8.
7. Zulaekah S. Efek suplementasi besi, vitamin C dan pendidikan gizi terhadap perubahan kadar hemoglobin anak sekolah dasar yang anemia di Kecamatan Kartasura Kabupaten Sukoharjo. 2007.

8. Susanti Y, Briawan D, Martianto D. Suplementasi besi mingguan meningkatkan hemoglobin sama efektif dengan kombinasi mingguan dan harian pada remaja putri. Jurnal Gizi Pangan. 2016;11.Aycicek A. Ferrous sulfate versus ferrous fumarate plus zinc sulfate and vitamin C for treatment of iron deficiency anemia in children. Global Journal of Hematology and Blood Transfution. 2015;2.
9. Worthington-Roberts BS, Williams SR. Nutrition throughout the life cycle. Fourth ed. McGrawHill International Editions, Health Profession Series. Singapore; 2000.
10. Zulaekah S, Kusumawati Y, Nugraheni R, Astuti RA. Hubungan tingkat sosial ekonomi keluarga dengan perilaku konsumsi FE remaja. Seminar Nasional Gizi 2017 Program Studi Ilmu Gizi "Strategi Optimasi Tumbuh Kembang Anak". 2017.
11. IDAI. Anemia defisiensi besi pada bayi dan anak. 2012.
12. Ikatan Dokter Anak Indonesia. Suplementasi Besi Untuk Anak.2011
13. Sherwood L. Human physiology : From Cells to Systems. 9th Ed. 2016.
14. Permatasari T. Efektivitas program suplementasi zat besi pada remaja putri di Kota Bogor. Jurnal MKMI. 2018; 14.
15. Schlueter AK, Johnston CS. Vitamin C: Overview dan Update. Journal of Evidence-Based Complementary & Alternative Medicine. 2011; 16.
16. Mehnaz S, Afzal S, Khan Z. Impact of iron, folate & vitamin C supplementation on the prevalence iron deficiency anemia in non-pregnant females of Peri Urban Areas of Aligarh. Indian Journal of Community Medicine. 2006; 31.
17. Wibowo MFA. Pengaruh suplementasi tablet dan vitamin C terhadap peningkatan kadar hemoglobin pada siswa kelas VI SDN Klego 01 Kota Pekalongan. 2010.
18. CaesarIa DC. Hubungan asupan zat besi dan vitamin C dengan kadar hemoglobin pada ibu hamil di Klinik Usodo Colomadu Karanganyar. 2015.
19. Astriningrum EP, Hardinsyah, Nurdin NM. Asupan asam folat, vitamin B12, vitamin C di Indonesia berdasarkan studi diet total. Jurnal Gizi Pangan. 2017;12