Biochemistry & Physiology: Open Access
ISSN: 2168-9652

Dinarsi et al., Biochem Physiol 2015, S5
DOI: 10.4172/2168-9652.S5-005

Research Article Open Access

Effect of Zinc Capsules To Physical Size of Born Babies in Malnutrition Pregnancy Women during Third Trimester in Bojonegoro, East Java Province

Herisa Dinarsi[1]*, Bambang Wirjatmadi[2] and Merryana Adriani[2]

[1]*Master Program of Public Health Faculty, Airlangga University, Surabaya, Indonesia*
[2]*Public Health Faculty, Airlangga University, Surabaya, Indonesia*

Abstract

Malnutrition is not only harm the physical and mental of mother, but also threatens safety of the fetus. Mothers who insisted pregnant with malnutrition status are at 2-3 times larger risk of giving birth to low birth weight babies than mothers with good nutritional status. This study is an experimental research with pretest-posttest control group design. The purpose of this study is to analyze the effect of zinc capsule to the physical size of born babies in malnutrition pregnant women during third trimester in Bojonegoro Regency, East Java province. The data was collection through questionnaire, food recall, food frequency, monitoring card, anthropometry, blood sampling, and laboratory tests. The population was pregnant women who living in 27 different locations in Bojonegoro Regency. The samples were 32 malnutrition pregnant women during their third trimester who registered in 6 health clinics. The sampling technique is done by simple random sampling. Samples are divided into two groups, the treatment group (n=16) and the control group (n=16). The results of this study showed there was a significant difference between treatment and control group regarding the weight ($p<0.000$), length ($p<0.000$), and head circumference ($p<0.029$) of the born babies. These results suggest that zinc supplementation has positive effect on the physical size of the birth.

Keywords: Zinc supplementation; Newborn physical size

Introduction

Nutritional problems happened in every life cycle, starting in the womb (fetal), infant, child, adult and elderly. The period of the first two years of life is a critical period, because in this period, growth and development occurs very rapidly. Nutritional disorder that occurs in this period is permanent, cannot be recovered even nutritional needs during the next period fulfilled.

In Indonesia, many cases of malnutrition especially are likely due to the imbalance of nutrient intake, so the nutrients that body needs are not fulfilled. This resulted in the growth of either physical or mental body is not perfect as it could be. According to Depkes RI [1] LILA measurements in women of childbearing age group is one way for early detection that is easy and can be done by ordinary people, to determine risk groups of malnutrition.

Based on the study of SUSENAS in 1999-2003, the risk of pregnant women for malnutrition ranges from 5-8% within 4 years. According to the Depkes in 2004, the prevalence of pregnant women with malnutrition has increased during the economic crisis that is 24.9%. Based on survey results from BPS in 2000-2005, pregnant women who suffer from malnutrition are 15.49% and the corresponding to National Development Program on nutrition improvement program in 2008 is expected to decrease malnutrition in pregnant women to 20 % [2]. According to Riskesdas 2007, prevalence of malnutrition pregnant women is 13.6% and the prevalence in East Java are 15.9%. Malnutrition in pregnant women except has an effect on the mother, also affects the fetus and affect labor. Adverse impacts of malnutrition in pregnant women are anemia, bleeding, weight of pregnant women do not grow normally, and puerperal sepsis infection. Effects of malnutrition on the fetus include miscarriage, stillbirth, neonatal death, birth defects, anemia in infants, intra-partum asphyxia (death in utero), low birth weight and Apgar score <10 (a score of newborn health). The survey results indicate that the prevalence of anemia among pregnant women is still very high at 51%, and 45% in post-partum mothers. While the prevalence of women of childbearing age (WUS) suffered malnutrition in 2002 was 17.6% [3]. Malnutrition and anemia in pregnant women are major causes of hemorrhage, obstructed labor, abortion, and infection which are major factors of maternal mortality.

The nutritional status of pregnant women is one of the indicators to measure the nutritional status of society. If the intake of nutrition for pregnant women from food is not balanced with the needs of the body, there will be a deficiency. Maternal and infant mortality rate in Indonesia are the highest in Southeast Asia. According to the Indonesian Demographic Health Survey in 2007, Maternal Mortality Rate (MMR) in Indonesia is 228 per 100,000 live births, while the Infant Mortality Rate (IMR) is 32 per 1,000 live births. Widyakarya Nasional Pangan dan Gizi VIII which took place in Jakarta, 17 to 19 May 2004 stated that one of nutritional problems in Indonesia is high Infant Mortality Rate (IMR), Maternal Mortality Rate (MMR) and infant as a result of chronic malnutrition [4]. Some research suggests that pregnant women in general, including in rural Indonesia consume less staple food, animal food, vegetable and fruit. The implication are demand of energy, animal protein, vitamins, and minerals including Zinc in pregnant women are not fulfilled [5,6].

Zinc absorption is affected by zinc status in the body. When more zinc is needed, zinc will absorbed more too. So did the type of food that affects absorption. Albumin in plasma is a major determinant of zinc absorption. Albumin is the main transport tool of zinc. Zinc absorption decreases if value of blood albumin decreased, for example, in malnutrition or pregnancy.

***Corresponding author:** Herisa Dinarsi, Master Program of Public Health Faculty, Airlangga University, Surabaya, Indonesia, Tel: 085648629003; E-mail: hdinarsi@yahoo.com

Received May 27, 2013; **Accepted** July 14, 2015; **Published** July 21, 2015

Citation: Dinarsi H, Wirjatmadi B, Adriani M (2015) Effect of Zinc Capsules To Physical Size of Born Babies in Malnutrition Pregnancy Women during Third Trimester in Bojonegoro, East Java Province. Biochem Physiol S5.005. doi:10.4172/2168-9652.S5-005

Most zinc using transferrin as a transport tool, which is also the transportation of iron. In a normal state transferrin saturation of iron usually less than 50%. If the comparison between the iron and zinc more than 2: 1, transferrin which available for zinc is reduced, thus inhibiting zinc absorption. Otherwise, high-dose of zinc will inhibits iron absorption [7].

According to Fung et al. in Arfiyanti [8] zinc concentration in the plasma of pregnant women fell 20 30% compared to non-pregnant condition that describes the expansion of plasma volume and zinc transfer from mother to fetus. Minerals zinc is essential for fetal growth and development as well as in the production of breast milk during lactation. Zinc absorption during pregnancy increased by 30% during the second and third trimesters. Increased absorption doubled during lactation due to the increasing need of zinc for breast milk synthesis.

Prevalence of malnutrition pregnant women in Bojonegoro based on reports from the Department of Health Bojonegoro in 2010 was 11.3% and 12.3% in 2011. Based on the data, description of previous research and few research that discusses zinc supplementation in malnutrition pregnant women that related to the physical size of the newborn babies and prevalence of malnutrition pregnant women in Bojonegoro is still high, so researchers are interested to know about the effect of zinc supplementation on the physical size of the newborns babies in malnutrition pregnant women in Bojonegoro by providing zinc supplementation tablets for malnutrition pregnant women during their third trimester of pregnancy until childbirth.

Methods

Study design and population

This study is a randomized study design using the Pre-Test Post-Test Control Group Design by double-blind treatment. From the purpose, this study is an experimental study which to analyze the effect of zinc sulfate and high dose vitamin A supplementation. Studied variables measured twice, before and after treatment. The population was pregnant women who living in 27 different locations in Bojonegoro Regency. The samples in this study were 32 malnutrition pregnant women during their third trimester who registered in 6 health clinics. The sampling technique is done by simple random sampling. Samples are divided into two groups, treatment group and control group, 16 women in both groups.

Informed consent and ethical clearance

Any pregnant woman who is the subject of this study has been agreed to be the subject of study by completing a written informed consent form. This study has also been approved by ethical committee of the Public Health Faculty of Airlangga University.

Supplement

Zinc sulfate and high dose vitamin A supplement were distributed to respondents.

Data collection

The data of this study was collection through a questionnaire, food recall, food frequency, monitoring card, anthropometry, blood sampling, and laboratory tests.

Anthropometric assessment

Anthropometric measurements are used to determine length, baby's weight and head circumference of the born baby.

Dietetic assessment

Information of dietary intake identified using food frequency and recall method to know consumption level of energy, protein, fat, carbohydrates, and zinc of respondents.

Result

Consumption rate

Consumption rate of pregnant women in this study is an overview of all types of food that consumed and measured with a food recall then converted into nutrients. The consumption rate in the pre-test where treatment group has not received zinc supplementation. The results of first recall can be seen in the table below.

Energy consumption rate

Table 1 show that the number of respondents in this study was 32 respondents. The average energy consumption rate in control group is higher than treatment group. Standard of RDA for energy in pregnant women during their third trimester by age group 19-29 years are 2200 kcal and 30-49 years age group are 2100 kcal.There is no difference of energy consumption rate between the treatment and control groups ($p<0.592$).

Carbohydrates consumption rate

The average carbohydrates consumption rate of respondents in treatment group is lower than control group but both still below RDA standard. Standard for carbohydrate consumption rate in third trimester pregnant women by age group 19-29 years which are 60- 75% of 2200 kcal, about 330 - 412 g and the age group 20-49 years which equal to 60-75% of 2100 kcal, about 315-393 g. There is no difference of carbohydrates consumption rate between the treatment and control groups ($p<0.521$).

Protein consumption rate

The average protein intake rate of respondents in treatment group showed 46.98 g and 45.18 g in the control group. This is far below the normal RDA for pregnant women during their third trimester which based on the age group 19-29 years are 67g and 30-49 years age group are 67g. There is no difference of protein intake rate between the treatment and control groups ($p<0.874$).

Fat consumption rate

Average fat consumption rate of respondents in the treatment group slightly lower than control group. Fat consumption rate of respondents still balanced with RDA standards by age group 19 -29 years which 10-25% from 2200 kcal i.e. about 24g-61 g and for age group 30-49 years at 10 -25% of 2100 kcal which are 23g-58g. There is no difference of fat consumption rate between the treatment and control groups ($p<0.732$).

Zinc consumption rate

The average zinc consumption rate in control group is higher than

Consumption Rate	Treatment Group (n=16)	Control Group (n=16)	p-value
Energy (kcal)	1460.70 ± 200.63	1516.28 ± 357.84	0.592
Carbohydrate (g)	218.06 ± 48.11	232.31 ± 73.49	0.521
Protein	46.98 ± 14.19	45.18 ± 15.13	0.874
Fat	44.22 ±7.07	44.82 ± 13.28	0.732
Zinc	0.27 ± 0.30	0.63 ± 1.20	0.924

Table 1: Average of pretest consumption rate of pregnant women in treatment group and control group in Bojonegoro, 2011-2012.

treatment group. These results was still below RDA because AKG standard for zinc consumption rate in third trimester pregnant women by age group 19-29 years is 11 mg and 11.5 mg for age group 30-49 years. Results of Mann Whitney test for zinc consumption rate also showed that there is no difference of zinc consumption rate between the treatment and control groups (p<0.924) (Table 1).

Physical size of born babies and apgar score

Body length: Based on Table 2, the average body length of born babies in the treatment group was higher with minimum 48 cm and maximum 49 cm than in control group with minimum 46 cm and maximum 47 cm. From statistical analysis, there are differences of body length between the control and treatment groups, where the group that receiving zinc had greater body length than the control group (p<0.000) (Table 2).

Birth weight: Average birth weight in the treatment group which receiving zinc supplement was higher with minimum 3100 g and maximum 3600 g than the control group with minimum body weight 2000 g and maximum 3000 g. From statistical analysis, there are differences of birth weight between both groups (p<0.000) (Table 2).

Head circumference: Average head circumference in the treatment group was slightly higher than in control group. From statistical analysis, there are differences of head circumference between the control and treatment groups, where the group that receiving zinc had greater head circumference than the control group (p<0.029) (Table 2).

Apgar score: In the control group the average Apgar score was lower than in the treatment group. Baby with Apgar score of minimum 2, which means babies with Apgar score 4-6 where babies are born with mild-moderate asphyxia and Apgar score a maximum of 3, which means the baby with Apgar score 7-10 where the baby was born normal. The results of t-test showed that there is no difference of Apgar scores between control and treatment groups (p<0.153) (Table 2).

The Apgar score is an assessment to determine the clinical classification of the baby with asphyxia, which is a condition where a newborn baby does not immediately breathe spontaneously and regularly after birth. Each assessment of Apgar score is assigned with 0, 1, and 2. From the results of the assessment can be determined whether baby is normal (Apgar score 7-10), mild-moderate asphyxia baby (Apgar scores 4-6) or suffering from severe asphyxia (Apgar scores 0-3).

Based on Table 3, the average Apgar scores of born babies in the treatment group is 3, i.e. baby with Apgar score of 7-10 where it is said that baby was born normal, with minimum and maximum Apgar score of 3 (baby with Apgar score of 7-10) which means that all babies in treatment groups are born normal.

Discussion

Consumption level

Energy: Maternal consumption rate was measured through a recall for energy, carbohydrates, protein, fat and zinc consumption rate. The average energy consumption rate of respondents in both groups showed 1460.71 kcal and 1516.28 kcal, where that numbers are not in accordance with the applicable RDA. Arisman [9] said that when a woman is pregnant, energy is the most important nutritional factors which associated with baby's weight at birth. The energy that required during pregnancy increased in each trimester of pregnancy. The energy required in the third trimester is used for the growth of the fetus and placenta. The results of recall showed that energy consumption rate of respondents still under RDA of energy for pregnant women and respondents with malnutrition, these circumstances may increase the risk of low birth weight when that woman give birth later.

Carbohydrates: The average carbohydrates consumption rate of respondents in treatment group is still below the RDA standard. Carbohydrates for pregnant women is a major contributor of total energy that needed by mothers, 60-75% of energy derived from carbohydrate intake. Therefore, when carbohydrate intake of respondents is low, it would result in lower energy intake. The addition of this energy should be done with addition of nutrient-dense foods, such as milk, meat and lean chicken, fish, eggs, nuts and it processed products such as tofu and tempeh [10].

Protein: The average protein consumption rate in treatment and control group were still below normal RDA for pregnant women in third trimester. Low protein intake on respondents will affect the total of energy intake in pregnant women. Protein is especially necessary for fetal growth the formation of red blood cells and source of calories [11]. If protein deficiency happened during pregnancy, it can lead to no optimal operation of zinc because zinc is essential for many metabolic processes, protein and blood formation, and healing wound. In addition, protein deficiency can also lead to inhibition of amino acids formation in pregnant women body, because proteins can produce energy to form glucose. When glucose in the body is limited, cells were forced to use protein to form glucose and energy [12].

Fat: The average fat consumption rate of respondents in the treatment group showed 44.22g and in control group was 44.82 g. Fat consumption rate on respondent still in AKG standards for fat

Variable	Treatment Group (n=15)			Control Group (n=15)			p-value
	Mean ± SD	Min	Max	Mean ± SD	Min	Max	
Body length (cm)	48.87 ± 0.74	48	49	46.60 ± 0.50	46	47	0.000
Weight (g)	3273.33 ± 148.64	3100	3600	2766.67 ± 276.88	2000	3000	0.000
Head circumference (cm)	33.47 ± 1.30	31	35	32.40 ± 1.24	30	34	0.029
Apgar Score	3.00 ± 0.00	3	3	2.87 ± 0.35	2	3	0.153

Table 2: The average physical size of born babies and apgar score in treatment group and control group post test in Bojonegoro Year 2011-2012.

Apgar Score	Categories	Treatment Group		Control Group	
		n	%	n	%
0-3	Babies with severe asphyxia	0	0.00	0	0.00
4-6	Babies with mild-moderate asphyxia	0	0.00	1	6.66
7-10	Normal baby	15	100.00	14	93.34
	Total	15	100.00	15	100.00

Table 3: Average category Apgar score of born babies in treatment group and control group post test in Bojonegoro, 2011-2012.

consumption rate of pregnant women in third trimester. Fat intake at most respondents obtained from fried foods. According to one respondent, egg and other animal side dish which usually consumed by fried. Increased rate of fat in third trimester may reflect savings mobilization of fat. Decreased rate of fatty acids in early pregnancy and then increases will reflect the high intake of mothers during pregnancy and decrease of fat storage and lipogenesis towards the end of pregnancy.

Zinc: The average zinc consumption rate of respondents in treatment and control group were still below RDA standard. Low intake of zinc in early pregnancy can contribute to growth retardation, low birth weight and premature birth. Zinc is very important because it is essential for cell division and tissues growth of the developing baby. Zinc deficiency also have long term effects on the baby such as immune system more susceptible to infection that also manifestation of developmental and behavioral problems in the future. Zinc deficiency which shown by the low zinc concentrations in plasma on pregnant women lead to 3-7 times an increase in premature rupture cases, 3 times greater occurrence of placental abruption and 2-9 times higher prevalence presence of normal plasma zinc. So intake of zinc in pregnant women should really be considered because it can affect the outcome at the time of delivery.

Physical Size of Born Babies and Apgar Score

Body length: Average body length of the born babies in treatment group was greater than control group.

Statistically, apart from food consumption rate of pregnant women, birth body length can be influence by supplementation that given during the third trimester of pregnancy. Danesh et al [13] investigated the effects of high-dose zinc supplementation in pregnant women who have a history of preterm birth, given zinc supplements 50 mg / day in the zinc sulfate form. The study says the average weight of born babies in the zinc group is greater than the placebo group (2960.6g vs. 2819.0g). Average body length of born babies in the zinc group is also greater than the placebo group (49.8cm vs. 49.1cm). Results of other studies conducted in Jogja by Damayanti [14] showed pregnant women who have malnutrition status 4.4% gave birth to a short baby while 4.4% gave birth to babies with normal body length. Based on the statistical test, there is a relationship between nutritional status of pregnant women with body length birth ($p<0.01$).

According to Cunnane [15] zinc affects the activity of several hormones such as human growth hormone, gonadotropins, sex hormone, prolactin, thyroid and corticosteroids. Levels of insulin-like growth factor 1 (IGF-1) increases in pregnant women who get zinc supplement. Increased of growth velocity due to zinc supplementation is associated with increased levels of IGF-1, it is suspected that effect of zinc on growth stimulation is done through changes of IGF-1 which circulating in the pregnant women body and get into the fetus through placenta, so it can affect the growth of the born baby's body length. Zinc interacts with important hormones which involved in bone growth, such as somatomedin-C, osteocalcin, testosterone, thyroid hormone, and insulin. Hence, zinc is closely associated with bone metabolism, so zinc acts positively on the growth and development that affect the body length of the baby at birth. Zinc levels in the bone are very high compared with other tissues. Except strengthening the bone matrix, zinc also facilitate the effects of vitamin D on bone metabolism through stimulation of DNA synthesis in bone cells. Zinc is very important during growth and baby development during pregnancy [16].

Weight: Average birth weight in the treatment group was greater than the control group. Statistically, it can be said that apart from food consumption rate, zinc supplementation also affect birth weight when given during the third trimester of pregnancy. Garg [17] stating that babies who born from mothers who have given zinc supplementation significantly more heavy than those who did not receive zinc supplementation, with the biggest difference when supplementation began in the third trimester of pregnancy apart from food consumption rate. Nutritional status of mother before pregnancy affect weight, body length, and head circumference at birth because linkage of the placenta.

A study conducted on 45 pregnant women in Yogyakarta [14], 4 of them is stated malnutrition by measuring upper arm circumference. The results mentioned that pregnant women with malnutrition who gave birth a normal weight baby are only 2.1%, while the percentage of low birth weight from malnutrition mothers or normal mother are same, ie 6.7%.

Birth weight is strongly influenced by the passage of baby food from mother through the placenta and also nutrients that are consumed by mother. Therefore, zinc supplementation is expected to improve the taste equity of pregnant women so it can increase pregnant women appetite, thus mother conditions become better and conditions of the placenta is also good. The good condition of the placenta in pregnant women can affect food intake to the fetus and can increase the baby's weight at birth later.

Head circumference: Average head circumference of born babies in the control group was smaller than treatment group. Statistically, it can be said that apart from food consumption rate, zinc supplementation can affect head circumference when given during the third trimester of pregnancy.

Zinc plays an important role in cell growth, particularly in the production of enzymes that are important for RNA and DNA synthesis. Zinc also abundant in the brain. The content of zinc in the brain ranks 5th after the muscles, bones, skin, and liver [18]. In the brain, zinc associated with proteins that may contribute to the structure and function of the brain. Therefore, zinc is essential for the function and development of brain that can affect the baby's head circumference at birth. With the presence of zinc supplementation, it can provide maximum brain development and can improve birth head circumference.

Zinc is an important nutrient for development of the central nervous system. It is guided by variety reasons, that are [19] enzymes that dependent to zinc involved in the growth of brain, zinc-finger proteins participate in brain structures and neurotransmitters, neurotransmitters which depends on zinc involved in memory function of the brain, zinc involved in the production of neurotransmitters precursor, and metallothionein 3 is a protein that binds with zinc in neurons.

Based on the description above, zinc supplementation can affect the baby's brain growth in the womb and also affect baby's head circumference at birth later. Zinc supplementation and good composition of nutrition during pregnancy can affect birth outcomes.

Apgar score: Average Apgar score of born babies in the treatment group was 7-10 where it is said that the baby was born normal similiar with control group. Statistically, there was no effect of zinc supplementation in both groups to Apgar score of the born babies. In this study, Apgar scores of born babies between treatment and control group was not seen significant changes, this is probably due to similiar maternal food consumption rate between both groups, thus zinc supplementation did not affect Apgar score of the born babies. Dewi [20] in her research stated that there were no significant differences Apgar

score of born babies in treatment group and the control group. The results of the analysis using Paired Test showed significant difference of weight gain, hemoglobin level, and consumption of nutrients (energy, protein, and Fe) before and after treatment ($p<0.05$). The analysis also showed there are significant differences of post protein consumption ($p<0.014$), birth weight ($p<0.010$), and the baby's body length ($p<0.006$) between the control group with treatment group 1 and 2. However, between treatment groups 1 and 2 found no significant difference. Considering that zinc supplementation can affect an increase of Hb and mother's appetite, increase the weight and length of born baby, it is recommended that iron supplementation program, which is given to pregnant women, conducted in conjunction with zinc supplementation by intermittent administration time. Besides, always consider nutrient consumption of pregnant women, both in quality and quantity.

Conclusion

Energy, protein, fat, carbohydrates, and zinc consumption rate concluded that there was no effect of supplementation between control and treatment groups. There is an effect of zinc supplementation on the physical size of the born babies, that are body length, weight, and head circumference in the treatment and control groups but there was no significant relationship between Apgar scores to supplementation that has been given to both groups. Result of this study showed that the average zinc consumption rate of respondents in treatment and control group were still below standard. Low intake of zinc in early pregnancy can contribute to growth retardation, low birth weight and premature birth.

Zinc is very important because it is essential for cell division and tissues growth of the developing baby. There is an effect of zinc supplementation on the physical size of the born babies, which are body length, weight, and head circumference. Zinc deficiency also has long term effects on the baby such as immune system more susceptible to infection that also manifestation of developmental and behavioral problems in the future. Zinc deficiency which shown by the low zinc concentration in plasma on pregnant women lead an increase in premature rupture cases, three times great occurrence of placental abruption. So intake of zinc in pregnant women should really be considered because it can affect the outcome at the time of delivery.

References

1. Depkes RI (1994) Pedoman Penggunaan Alat Ukur Lingkaran Lengan atas(LILA) pada Wanita Usia Subur. Jakarta: Ditjen Pembinaan Kesehatan Masyarakat, Depkes.
2. Herman, Susilowati (2009) Studi masalah gizi mikro di Indonesia: Perhatian khusus pada Kurang Vitamin A (KVA, Anemia, dan Seng). Bogor: Puslitbang Gizi dan Makanan.
3. Sulistyowati (2008) Kurang Energi Kronik Pada Ibu hamil.
4. Widya Karya (2004) Pangan dan Gizi, LIPI. Jakarta: Departemen Kesehatan RI.
5. Hardinsyah D, Briawan CM, Dwiriani, Karsin E (1998) Upaya perbaikan gizi ibu dan anak di Leuwiliang Bogor: Jurusan GMSK Faperta, IPB.
6. Mailoa M (1998) Pengembangan Cara Sederhana Penilaian Mutu Gizi Makanan Ibu Hamil di Kec. Bogor Timur, Bogor. Jurusan GMSK; Faperta; IPB.
7. Almatsier S (2009) Prinsip Dasar Ilmu Gizi. Gramedia Pustaka Utama: Jakarta.
8. Arfiyanti (2002) Pengaruh suplementasi besi-folat terhadap status Zn: studi pada ibu hamil di Kabupaten Demak. Program Pascasarjana Ilmu Biomedik: Semarang: Diponegoro University.
9. Arisman (2007) Gizi Dalam Daur Kehidupan. Buku Kedokteran EGC: Jakarta.
10. Almatsier S (2011) Gizi Seimbang Dalam Daur Kehidupan. Gramedia Pustaka Utama: Jakarta.
11. Almatsier S (2003) Prinsip Da sar Ilmu Gizi. Gramedia Pustaka Utama: Jakarta.
12. Almatsier S (2009) Prinsip Dasar Ilmu Gizi. Gramedia Pustaka Utama: Jakarta.
13. Danesh A, Janghorbani M, Mohammadi B (2010) Effect of zinc supplementation during pregnancy on pregnancy outcome in women with history of preterm delivery: A double-blind randomized placebo controlled trial. The Journal of Maternal-Fetal and Neonatal Medicine 23: 403-408.
14. Damayanti E (2009) Hubungan Status Gizi Ibu Hamil Dengan Berat Badan dan Panjang Badan Bayi Baru Lahir di Puskesmas Mergansang, Yogyakarta. Faculty of Medicine. Gajah Mada University Yogyakarta.
15. Cunnane SC (1988) Zinc Clinical and Biochemical Significance. ORC. Press Inc: 1-51, Florida.
16. Riyadi H (2007) Zinc (Zn) for Growth and Child Development. Bogor: Bogor Agricultural University.
17. Garg HK, Singhla KC, Arshad Z (1993) A study of the effect of oral zinc supplementation during pregnancy on pregnancy outcome. Indian J. Physiol Pharmacol 37: 276-284.
18. Mills CF (1989) Zinc and Human Biology. ILSI Press, Washington DC 131: 173-181.
19. Salgueiro MJ, Zubillaga M, Lysionek A, Sarabia MI, Caro R, et al. (2000) Zinc as an essential micronitrient: a review. Nutr. Res 20: 737-755.
20. Dewi RC (2008) Pengaruh Suplementasi Tablet Tambah Darah (TTD), Zinc, dan Vitamin A Terhadap Kadar Hemoglobin Ibu dan Nilai Apgar Score Serta Berat Bayi Lahir. Public Health Faculty.

This article was originally published in a special issue, **Zinc: Biological role and signi icance** handled by Editor(s). Airlangga University, Indonesia