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Zinc Deficiency and Inadequate Zinc Intake among Postpartum Women in Coastal Area of Makassar, Indonesia

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Summary Zinc deficiency was common among women, which mainly determined by adequacy of zinc intake, type of zinc compound in the diet, and presence of inhibitors of zinc absorption. This study aimed to assess the zinc status and zinc intake among postpartum women. A cross-sectional study was conducted in three community health centres located in coastal area of Makassar, Indonesia. Eighty-seven women participated in the study. A short Semi-Quantitative Food Frequency for zinc sources was used to collect dietary data. Venous bloods were drawn from all woman and serum zinc concentrations were measured using QuantiChrom™ Zinc Assay Kit (DIZN-250). Pearson correlation tests were undertaken to investigate relationship between zinc intake, phytate intake, and serum zinc concentration. All women were zinc-deficient (<66 mcg/dL) and 21.8% respondents had inadequate zinc intake. The average zinc intake was 15.9 mg/d with rice and legumes were the main contributors to zinc intake (54.10% and 11.33%, respectively). The average phytate intake was 6.5 gram/d, also with rice and legumes as the main contributors (63.30% and 14.97%, respectively). No significant association was observed between zinc intake and serum zinc concentration as well as between phytate intake and serum zinc concentration (r=0.063; p=0.053 and r=0.150; p=0.165, respectively). Postpartum women in coastal area of Makassar were zinc deficient and had low intake of zinc. The main dietary zinc sources were mainly plant source foods which have low bioavailability and high phytate content.

Key Words zinc, postpartum, women, coastal area, micronutrient

Zinc deficiency is one of prevalent micronutrient deficiencies worldwide. However, implementation of zinc deficiency prevention and control program is still rarely undertaken due to lack of data on zinc deficiency in high-risk populations. Few studies in Indonesia observed that pregnant women and lactating mothers are vulnerable to zinc deficiency, but limited evidence is available for the risk of zinc deficiency among postpartum women. Dijkhuizen, et al. in 2001 reported 25% of lactating mothers in Bogor district of West Java were zinc deficient (<10.7 μmol/L)(*1*). The higher prevalence of zinc deficiency was observed in some small studies conducted in South Sulawesi Province. Syah in 2012 (unpublished data) reported that all (n=80) pregnant women in rural village in Bontonompo district of South Sulawesi province had low serum zinc concentration (<65 mg/L). Also, Kurniati in 2017 (unpublished data) found that all of 70 postpartum mothers who delivered at Fatimah Mother and Child Hospital in Makassar city experienced low serum zinc concentration.

Zinc absorption from diet is about 20–40%. The rate of absorption depends on food sources. Zinc is more commonly found in animal source foods such as fish and meat, where zinc is bound to proteins so that is easily absorbed (*2*). However, these animal source foods are expensive, thus not affordable by low economic population group. Plant food sources such as fruits and vegetables are cheaper and more commonly consumed, however zinc from plant source foods is absorbed less because it is bound to phytate or oxalate (*2*). Additionally, the amount of zinc in plant source foods are highly dependent on zinc concentration in the soil (*3*) and the content of zinc in soil is low in coastal area (*4*).

Previous studies among children in coastal area of Indonesia showed a high prevalence of zinc deficiency, low zinc intake, and high phytate-rich foods consumption (*5*, *6*). Therefore, this study aimed to assess zinc status, and zinc and phytate intake and their relationships among postpartum women living in coastal area.

MATERIALS AND METHODS

A cross-sectional study was conducted with total sample of 87 postpartum women who had 4–6 wk old babies. Samples were selected purposively from three health centers that located within coastal area of Makassar city. The inclusion criteria were: (1) women who have given birth at least 4 wk prior to data collection; (2) not consuming zinc supplements; (3) not suffer from severe infection and willing to participare in the study. About 3 mL non-fasting blood samples were col-

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lected in the morning by health center staff from each postpartum mother. Data on consumption of zinc and phytate sources were collected by trained enumerators with nutritional background, using validated short Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) containing 24 food items from animal- dan plant-food sources that were consumed over the last 6 mo (*7*). Total daily zinc and phytate intake were analysed and calculated by Nutrisurvey program based on the Indonesian Food Composition Database. Zinc intake was categorized as adequate if the total intake was ≧80% RDI and as inadequate if <80% RDI. In order to estimate the absorption of zinc, phytate:zinc molar ratio was calculated using suggested formula by International Zinc Nutrition Cosultative Group (*8*). Serum zinc concentration was examined using the Quanti-Chrome™ Zinc Assay Kit (DIZN-250) in the laboratory of Hasanuddin University Medical Research Centre. Zinc status was categorized as normal if serum zinc concentration ≥66 mcg/dL and deficient if <66 mcg/dL. Chi-square test was performed to examine the relationship between two categorical variables, while Pearson correlation test was to examine the relationship between two continuous variables. The study protocol was approved by the Ethical Committee of the Faculty of Public Health Hasanuddin University.

RESULTS

Most of post partum women were young adult (59.8%), had multipara pregnancy (71.3%), and never experiencing abortus (94.3%). Respondents were come from various social economic status. Most of the respondents were unemployed (81.5%). A total of 55.2% women were come from low income family. In addition the education level of 27.5% women and 31% husband were below senior high school (Table 1).

The average zinc intake was 15.95 mg/d and there were 21.8% postpartum women had daily zinc intake below 80% RDI. The mean serum zinc concentration was 6.30 mcg/dL, and all women were zinc deficient. The result of chi-square test showed there was no association between zinc intake and zinc status ($p>0.05$) (Table 2). The Pearson correlation test showed no significant correlation between zinc intake and serum zinc concentration ($r=0.063$; $p=0.563$) (Table 3).

Pearson correlation test showed no significant correlation ($r=0.150$; $p=0.165$) between phytate intake and serum zinc concentration (Table 3). Similarly, no correlation was observed between phytate:zinc molar ratio and zinc concentration ($r=0.140$; $p=0.196$) (Table 3).

The main sources of zinc were rice, beans and legumes, and processed meat. As many as 54.10% (8.17 mg/d) of the daily zinc intake came from rice, 11.33% (1.98 mg/d) from beans and legumes, and 7.63% (1.32 mg/d) from processed meat. Contributions of animal sources such as red meat, poultry, fish, seafood, oyster, and egg ranged from 0.01% to 3.78% to daily zinc intake. Dairy products contributed from 0.01–0.21% of daily zinc intake (Table 4).

Table 1. Characteristics of respondents.

Characteristics	*n*	%
Age (y)		
<19	5	5.7
20–29	52	59.8
30–49	30	34.5
Pregnancy		
Primipara	25	28.7
Multipara	62	71.3
Abortus history		
Yes	5	5.7
No	82	94.3
Employment		
Yes	71	81.6
No	16	18.4
Average household monthly income		
<Rp 1.500.000–2.500.000	48	55.2
Rp 2.500.000–>3.500.000	39	44.8
Level of Education		
Lower than senior high school	24	27.5
Senior high school and above	63	72.5
Husband Level of Education		
Lower than senior high school	27	69.0
Senior high school and above	60	31.0

Table 2. Association between zinc intake and zinc status.

Zinc intake	Zinc status				Total (%)	*p*-value*
	Low		Very low			
	n	%	*n*	%		
Adequate	26	38.2	42	61.8	68 (78.16)	0.125
Inadequate	11	57.9	8	42.1	19 (21.84)	
Total	37	42.5	50	57.5	87 (100)	

* Chi-square test.

Table 3. Pearson correlation coefficient of serum zinc with zinc intake, phytate intake and phytate:zinc molar ratio.

	Serum zinc	
	*r**	*p*-value*
Zinc intake	0.063	0.563
Phytate intake	0.150	0.165
Phytate:zinc molar ratio	0.140	0.196

* Pearson correlation test.

Table 4. Average daily consumption of zinc based on the sources of zinc and the contribution to total daily zinc intake.

Foods	Average daily consumption (g)	Average daily zinc intake (mg)	Average contribution of sources of zinc to daily zinc intake (%)	Mean contribution of sources of zinc to daily zinc intake by zinc intake category (%)	
				Low intake	Adequate intake
Red meat	43.21	0.40	2.47	2.12±2.26	2.59±4.29
Processed meat	122.01	1.32	7.63	5.87±5.61	8.26±9.41
Sea water fish	74.65	0.54	3.53	4.07±3.33	3.33±2.84
Fresh water fish	15.40	0.05	0.29	0.10±0.20	0.36±1.05
Canned fish	7.01	0.002	0.01	0.02±0.12	0.15±0.05
Oyster	6.95	0.06	0.34	0.25±0.86	0.38±0.98
Seafood	31.62	0.08	0.50	0.37±0.33	0.55±0.78
Egg	67.58	0.61	3.74	1.17±1.19	3.95±4.98
Nuts	33.90	0.59	3.24	1.17±1.19	3.9±7.08
Beans and legumes	87.70	1.98	11.33	5.70±4.49	13.35±12.04
Corn	128.85	0.31	1.81	1.07±1.77	2.07±2.96
Rice	248.85	8.17	54.10	65.51±7.34	59.01±14.14

Table 5. Average daily consumption of phytate based on the sources of zinc and the contribution to total daily phytate intake.

Foods	Average daily consumption (g)	Average daily phytate intake (mg)	Average contribution of sources of phytate to daily phytate intake (%)	Mean contribution of sources of zinc to daily zinc intake by zinc intake category (%)	
				Low intake	Adequate intake
Nuts	33.90	640	8.21	3.27±3.26	9.98±14.74
Beans and legumes	87.70	1,079	14.97	0.19±0.88	17.47±14.56
Corn	128.85	752	9.50	5.83±8.29	10.82±14.20
Rice	248.85	3,751	63.30	78.77±9.09	57.74±18.05

The average phytate intake was 6,477.07 mg/d (SD± 2,699.12). Rice also contributed to 63.30% of daily phytate intake besides other major sources of phytate such as beans and legumes (14.97%), corn (9.5%), and nuts (8.2%). Phytate:zinc molar ratio was 39.95 (SD± 8.39), indicates low level of absorbable zinc (Table 5).

DISCUSSION

Zinc Status

This study found that postpartum women were at risk of zinc deficiency, which agrees with the previous findings in the same Province by Syah and Kurniati (unpublished data). The prevalence of zinc deficiency in this study was higher than that found among lactating mothers in rural West Java (*1*), rural Vietnam (*9*), and in peri-urban community Ecuador (*10*). This study also confirmed that people living in coastal area of Indonesia might be at high risk of zinc deficiency since 100% of postpartum women were zinc deficient as defined by serum zinc concentration, similar to the rate observed in children in coastal area of Semarang—Central Java (*5*).

The risk of zinc deficiency among postpartum women may relate to the increased demand during lactation while intake of absorbable zinc is insufficient to meet the demand. This present study found that 78% of postpartum women met daily zinc intake ≥80%RDA, with the mean intake of 15.95 mg/d. On the other hand, phytate intake (6,477.07 mg/d) and phytate:zinc molar ratio (>15) were also high. These indicated that while zinc intake might be adequate, but the absorbable zinc intake might be low due to the plant foods as the main sources of zinc. Increased zinc requirement was also affected by pregnancy and lactating status (*8*). Of the women, 85.15% were breastfeeding. Impairment of zinc utilization in the body related to frequent infections, inflammatory diseases, gestational disorders, or diarrhea, may also contribute to the low zinc level (*8*). There was no data on infections or diarrhea from the women, however hygiene practices and sanitation were presumably poor in coastal area of Indonesia (*11*).

Zinc and phytate intake

The results of this study showed there was 21% of postpartum women had zinc intake below recommended level. The study finding also indicated a tendency that increased zinc intake was in line with increased serum zinc concentration, however, we could not detect significant association between serum zinc concentration and zinc intake probably due to small sample size with all of the participants had very low to low zinc level. It is surprising that despite they lived in coastal area where fish are abundantly available, the consumption of animal sources including fish was limited. Similar condition was observed in a study among children in coastal area of Semarang (5) which the main sources of zinc were vegetables and legumes.

Phytate intake was not correlated with serum zinc concentration. Previous study among healthy reproductive-age women in Nepal found that plasma zinc concentrations was not associated with zinc intake (*12*). However, the study found that phytate consumption had a significant relationship with plasma zinc levels. Similar to the Nepali study, the phytate: zinc molar ratio was high but not correlated to zinc concentration in the present study. This could be an indication that rather than zinc and phytate intake, there are other factors may correlate with zinc status of the postpartum women in the area but they have not been investigated in this study. In addition, zinc absorption is also influenced by other nutrients such as fiber, iron, and calcium (*13*).

Limitations

This study has several shortcomings that should be considered when interpreting the results of the study. The use of Semi Quantitative FFQ to measure food intake for the last 6 mo could create possibility of overestimation or underestimation of the amount of food consumed. This potential bias had been minimized by using standardized food photography for Indonesians. In addition, the time to complete all data collection were quite long (approximately three months) then could result in reduced stability of blood samples storage. Sanitation and other environmental conditions that could relate to infections as well as health conditions that may affect intestinal malabsorption of the participants were not measured, thus there might be participants with malabsorption condition were included in the analyses.

CONCLUSION AND IMPLICATION

In conclusion, our study indicates that postpartum women in coastal area had high risk of zinc deficiency. These women relied heavily on plant food sources for their daily zinc intake. More attention should be put to improve nutritional status, particularly micronutrients status, among postpartum women and community living in coastal area of Indonesia.

Disclosure of state of COI

No conflicts of interest to be declared.

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