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Maternal factors associated with vitamin A concentration in colostrum of postpartum mothers in South Sulawesi Province, Indonesia

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ABSTRACT

Introduction: Newborns have low vitamin A reserves and rely on breastmilk to meet their vitamin A needs. This study aimed to determine factors associated with vitamin A concentration in colostrum of rural postpartum mothers. **Methods**: Out of 180 postpartum women interviewed at seven Community Health Centers in South Sulawesi Province, 160 who met the inclusion criteria were included in the study. Breastmilk (colostrum) samples were obtained shortly after delivery from the breast that was not full and not fed to the infant for at least 30 min. Breastmilk samples of 3-5 mls were collected into sterile plastic tubes using a manual pump. The samples were immediately placed in an icebox and transported to the laboratory within six hours after collection. Vitamin A concentrations were determined using HPLC method. Socioeconomic characteristics, anthropometric measurements, gestational age, and dietary intake of mothers (24-hour recall) were obtained. Bivariate and multiple linear regression analysis were undertaken to determine factors associated with vitamin A concentration in colostrum. **Results:** Dietary assessment showed unsatisfactory intake levels of calories, fat, protein, vitamin A, iron and zinc compared to the recommendations for Indonesia. Mean vitamin A concentration in colostrum was 58.2 μg/dl, and about 81.2% of the participants had normal colostrum vitamin A concentration. Iron intake and gestational age were significantly associated with colostrum vitamin A concentrations. **Conclusion:** Majority of the postpartum mothers had normal colostrum vitamin A concentration. Maternal dietary intake including iron is important to ensure adequacy of vitamin A in breastmilk.

Keywords: Breastmilk vitamin A, colostrum, postpartum mother

INTRODUCTION

Vitamin A deficiency remains a public health problem in developing countries affecting women of reproductive age, children and pregnant women (WHO 2011; Ayah *et al.,* 2007). More than 7.2 million pregnant women in developing countries are considered vitamin A deficient, whereas 13.5 million are considered to have a low vitamin A status (Gogia & Sachdev, 2010).

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Vitamin A plays an important role in vision, growth, physical development and immune functions (Fujita *et al.,* 2011). Vitamin A deficiency increases the risk of night blindness and other vision disorders, such as xerophthalmia. Vitamin A also helps maintain maternal health during pregnancy and lactation (Bahl *et al.,* 2002). There is a close relationship between vitamin A deficiency and an increase in the occurrence of diarrhoea as well as death in children. Furthermore, a low vitamin A status is related to high incidences of other diseases, such as dysentery, measles and acute respiratory infections (Imdad *et al.*, 2016).

Infants born to vitamin A-deficient mothers have an increased risk of vitamin A deficiency later in life (Klemm *et al.,* 2008; Rotondi & Khobzi, 2010). The infant is protected from vitamin A deficiency through breastfeeding when the vitamin A level in breastmilk is adequate. Vitamin A concentration in breast milk reaches its optimum level in the first 21 days postpartum, namely in the colostrum in the first 4–6 days and in the transitional milk thereafter (WHO, 2011).

In Indonesia, several studies have shown that the mean vitamin A concentration in breastmilk is relatively low according to World Health Organization (WHO) standards (< 20.0 μg/dl) (Dijkhuizen *et al.,* 2001; Permaesih & Rosmalina, 2008; Permaesih, 2009; Permaesih, Rosmalina & Tanumihardjo, 2014). Dietary intake of vitamin A among Indonesian women was only one-third of the recommendation (Cahyanto & Roosita, 2013). The Indonesian Basic Health Research in 2010 reported that one out of two post-partum women received vitamin A supplementation (Kemenkes, 2010), which was lower than the coverage of vitamin A supplementation of infants.

Various factors, such as food intake, maternal nutritional status, age, parity and pregnancy duration are known to modulate the secretion of vitamin A in breastmilk (Campoos, Paixao & Ferraz, 2007; Mello-Neto *et al.,* 2009). Moreover, micronutrient interactions, such as between iron and zinc, may also modify the levels of vitamin A in the body. Research shows that iron deficiency is associated with low plasma retinol levels and increased hepatic vitamin A (Oliveira *et al.,* 2008). The purpose of the present study was to determine maternal factors associated with vitamin A concentrations in colostrum.

MATERIALS AND METHODS

This cross-sectional study was conducted in seven Community Health Centers (Puskesmas) in Gowa District between July and November 2017. Gowa is about 20 km from Makassar, the capital city of the South Sulawesi Province.

At the screening stage, 187 pregnant women were interviewed, out of whom, 160 who met the inclusion criteria were included in the study. These criteria were delivery with singleton pregnancy between 37 and 40 weeks of gestation, normal birth weight (≥ 2500 g), vaginal delivery and maximum parity of three. Meanwhile, exclusion criteria were diagnosed human immunodeficiency virus (HIV) infection, diabetes mellitus, hypertension and severe mental disorder. The information about postpartum disease (especially related to diseases in the exclusion criteria) was obtained by asking the mother directly or based on previous diagnosis by health personnel.

A questionnaire was developed to obtain information regarding socio-economic characteristics, pregnancy history, and lactation duration among the participants. Dietary intake of the mothers was assessed using a 24-hour recall questionnaire. Dietary intake data was then analysed using Nutrisurvey

2007 software and the findings were compared with the recommended dietary allowance (RDA) for Indonesia (Kemenkes, 2013). Anthropometric data and breastmilk samples were collected after the interview. Body weight was measured using a SECA digital weighing scale (Model SECA 813, Hamburg, Germany), while a microtoise tape was used to measure height (GEA medical SH-2A, Germany), following which body mass index (BMI) was computed. The anthropometric measurements were performed on lightly clothed barefooted participants.

Breastmilk samples were obtained a few days after delivery, as it is known that colostrum reaches a maximum level by the third day. Before taking breastmilk, the participant was told to clean the breasts with a clean wet cloth. Milk was taken from the breast that was not full and was not used for feeding the infant for at least 30 min for sampling consistency. Breastmilk of 3-5 ml was collected from each mother using a manual pump between 9am-12pm. The breastmilk samples were collected into sterile plastic tubes, which were immediately placed in an icebox and transported to the laboratory within six hours of collection. In the laboratory, the samples were stored at –20°C. Breastmilk vitamin A analysis was performed using high-performance liquid chromatography (HPLC) method (Esposito *et al.,* 2017) at the Integrated Nutrition Laboratory of the Health Research and Development Agency in Bogor, Indonesia.

Univariate data analysis was performed to describe the distribution of each research variable. Bivariate analysis was conducted using Pearson correlation test and multiple linear regression analysis was performed to determine the factors associated with colostrum vitamin A concentrations. A *p*-value of <0.05 was considered significant.

This study was approved by the Human Research Ethics Committee under the Research and Community Service Institute of Bogor Agriculture University (No. 01/IT3.KEPMSM-IPB/SK/2017). Informed consent was obtained from the participating women before the commencement of the study.

RESULTS

Mean maternal age of the mothers was 26.9 years, with more than one-third aged 20–25 years (43.1%) (Table 1). The average duration of education was 9.9 years with about half of them (48.8%) having completed formal education for at least 12 years.

Most of the participants were housewives (91.9%). On average, mothers had parity of 2.1 and majority (72.5%) were in the multiparous category (parity ≥ 2). Most of the infants were born at 37 weeks of gestation (78.0%). Mean BMI of the mothers was 23.1 kg/m^2, with 17.5% overweight, 13.8% obese and 9.4% underweight.

Mean vitamin A concentration in colostrum was 58.2 µg/dl. More than two-thirds (81.2%) had normal colostrum vitamin A concentration with 18.8% having a low concentration.

Dietary intake assessment showed mean fat and protein intakes were low, at 41.1 g and 56.7 g per day, or achieving respectively 52.3% and 74.1% of the RDA for Indonesia. Mean calorie intake was 1448 kcal or about 57.2% of the RDA. As for micronutrient intake, mean vitamin A intake per day was 508.0 µg or 59.7% of the RDA. Maternal vitamin A intake was shown to be higher than that for zinc and iron. Mean zinc and iron intakes were 5.8 µg and 6.3 mg per day, or 38.6% and 19.7% of the RDA, respectively.

Bivariate analysis showed that only iron intake of the mothers was significantly related to vitamin A concentrations in the breastmilk samples (Table 3). Intake of vitamin A

Table 1. Characteristics of postpartum mothers

Maternal characteristics	*n*	*%*	*Mean±SD*
Age (years)			26.9±4.9
20 – 25	69	43.1	
26 – 30	48	30.0	
31 – 35	43	26.9	
Education (years)			9.9±3.3
< 9	46	28.7	
9 – 11	36	22.5	
≥ 12	78	48.8	
Occupation status			NA
Unemployed / housewife	147	91.9	
Work	13	8.1	
Parity (number)			2.1±0.7
1	44	27.5	
2	64	40.0	
3	52	32.5	
Gestational age (weeks)			37.5±1.1
37	126	78.0	
38	5	3.1	
39	7	4.4	
40	22	13.8	
Body mass index (kg/m^2)			23.1±3.5
Underweight (<18.5)	15	9.4	
Normal (18.5 – 24.9)	95	59.4	
Overweight (25.0 – 26.9)	28	17.5	
Obese (≥27.0)	22	13.8	
Breastmilk vitamin A (µg/dl)			58.2±44.8
Low (≤ 30.0)	30	18.8	
Normal (>30.0)	130	81.2	

Table 2. Dietary intake of vitamin A, zinc, fat and protein among postpartum mothers

Intake per day	*Mean*	*S.E*	*Minimum - Maximum*	*%RDA*[†]
Calorie intake (kcal)	1448.2±402.2	31.79	701.7 -2196.3	57.2
Fat intake (g)	41.1±23.5	1.85	6.3 – 89.6	52.3
Protein intake (g)	56.7±18.8	1.49	19.5 – 95.0	74.1
Vitamin A intake(µg)	508.0±286.0	22.61	12.2 – 989.4	59.7
Zinc intake (µg)	5.8±2.3	0.18	2.1 – 18.0	38.6
Fe intake (mg)	6.3±2.9	0.23	2.4 – 20.9	19.7

[†]RDA = recommended dietary allowance (Kemenkes, 2013)

and zinc, as well as fat and protein intake did not show significant correlation with colostrum vitamin A concentration.

Multiple linear regression analysis showed that, among the studied factors, only maternal iron intake (coefficient beta=3.091; *p*=0.048) and gestational age (coefficient beta= –6.994; *p*=0.046) were significantly associated with colostrum vitamin A concentrations.

Table 3. Bivariate analysis of factors related to vitamin A concentrations in colostrum

Factors	*r*	*p*
Body mass index	-0.007	0.926
Vitamin A intake	-0.047	0.554
Zinc intake	-0.043	0.591
Iron intake	0.163	0.040*
Fat intake	-0.128	0.108
Protein intake	-0.049	0.540
Maternal age	0.096	0.226
Parity	0.047	0.552
Gestational age	-0.115	0.147

*Significant at $p<0.05$,
r: coefficient correlation, *p*: significance level

Table 4. Multiple linear regression analysis of factors related to vitamin A levels in colostrum

Factors	*Coefficients Beta*	*S.E*	*95% CI*	*p*
Fe intake	3.091	2.81	-2.478 to 8.662	0.048*
Gestational age	-6.994	3.45	-13.778 to -0.111	0.046*
Constant	322.104	139.49	46.468 to 597.74	0.022*

*Significant at $p<0.05$, $R^2=0.075$

The latter negative finding indicates that as gestation age prolongs, vitamin A concentration in breast milk decreases. Moreover, as the R^2 value obtained in the study was low at 0.075, indicating that only 7.5% of the variations in the colostrum vitamin A concentration could be explained in a linear manner by the study model, which includes the factors shown in Table 3. Thus, there are several other factors that could potentially influence colostrum vitamin A concentration of the study participants.

DISCUSSION

In the studied sample of mothers, iron intake and gestational age at delivery were significantly related to vitamin A concentrations in colostrum. The result indicates the importance of adequate maternal dietary intake of iron, and possibly other macro- and micronutrients in influencing vitamin A concentrations in breast milk. Weekly iron supplementation of Indonesian mothers during pregnancy increased vitamin A concentration in breastmilk (Muslimatun *et al.,* 2001). Iron deficiency can alter the metabolism of vitamin A, leading to a decrease in the activity of retinyl ester hydrolases, or an increase in retinol sequestration to the liver (Oliveira *et al.,* 2008).

There was no association between maternal age and vitamin A concentration in breastmilk. However, Mello-Neto *et al.* (2009) had previously reported a positive association between maternal age and vitamin A levels in breastmilk. This difference in findings could be because of a wider age range among postpartum mothers in the previous study (16–41 years) than in the present study of 20–35 years.

High parity has been shown to be associated with low fat levels in breastmilk that can ultimately affect vitamin A levels in breastmilk (Muslimatun *et al.,* 2001). However, there was no observed relationship between parity and vitamin A levels in breastmilk in this study. This finding is in agreement with the study of Panpanich *et al.* (2002), which reported that parity was not associated with vitamin A concentrations in serum or breastmilk.

Generally, vitamin A concentration in breastmilk is quite high in the first 21 days after delivery (colostrum breastmilk for 4–6 days and transition breastmilk for 7–21 days) (WHO, 2011). The current study found that the mean vitamin A concentration in colostrum was 58.2 μg/dl. This value is slightly lower than that among Brazilian mothers reported by by Lira *et al.* (2011) (60.0 μg/dl), but higher than that of another study in Brazil (46.8 μg/dl) (Grilo *et al.,* 2015).

Vitamin A intake is essential during pregnancy and throughout the breastfeeding period, and it plays a vital role in the healthy development of the foetus and new born, particularly lung development and maturation (Strobel, Tinz & Biesalski, 2007). In this study, there was no observed association between vitamin A or zinc intake and vitamin A levels in breastmilk. This is in line with a research conducted by Deminice *et al.* (2018) which found no correlation between maternal vitamin A intake and levels of vitamin A in breast milk and blood serum. In contrast, we found that low iron intake was associated with low vitamin A levels in breastmilk. Mothers in the study showed iron intake that was about one-fifth of the RDA. Iron deficiency has been shown to be associated with reduced serum vitamin A levels and increased hepatic vitamin A levels (Oliveira *et al.,* 2008).

The percentage of body fat in breastfeeding mothers may influence the vitamin A levels in breastmilk, considering that fat is required for the transport of vitamin A and other fat-soluble vitamins. However, excess body fat may negatively affect body vitamin A concentration. Adipose tissue in obesity is reported to synthesise retinol binding protein (RBP) that is released into circulation not bound to retinol (Mills, Furr & Tanumihardjo, 2008).

In the present study, BMI was measured instead of body fat composition, and this may be one of the study limitations. Other limitations were that several factors related to vitamin A levels in breastmilk were not assessed in this study, owing to limited resources to conduct this study.

CONCLUSION

Most postpartum mothers in this study had normal colostrum vitamin A concentrations. Future studies should include more factors, including dietary intake of micronutrients, and body fatness, for a better understanding of the influencing variables on micronutrients in breast milk.

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Authors' contribution

AS, designed and conceptualised the study, conducted analysis and interpretation of data, drafted the article, and approved final version to be published; DB, designed, conceptualised the study and drafted the article; DM, designed, conceptualised the study and drafted the article; ART, designed and conceptualised the study, conducted analysis and interpretation of data; AIA, conducted analysis and interpretation of data and conceptualized the content; LAAW, conceptualised the content.

Conflict of interest

All authors declared no conflict of interest in conducting this study.

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