Vitamin A Intake is Low Among Pregnant Women in Central Java, Indonesia

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Abstract: From 1996–1998, a longitudinal study on nutritional status during pregnancy was carried out in Purworejo District, Central Java, Indonesia. Dietary intake was assessed in each trimester using six 24-hour recalls, and analyzed cross-sectionally among 493 women. The proportion of women below the Indonesian RDI for vitamin A (700 RE) ranged from 83% in the first trimester to 76% in the third. Regardless of total vitamin A intake, plant sources contributed 64–79% in all three trimesters. The contribution from animal and fortified sources was generally lower throughout pregnancy for those with low education compared to those with high education. Significant risk factors for having a low vitamin A intake (< FAO/WHO basal RDI, 370 RE) in the second and third trimesters were fewer than six years of education, low socio-economic status, a low energy intake, and a low vitamin A intake in the previous trimester. Home gardening and chicken-raising were not positively associated with vitamin A intakes. Given the large percentage of women with inadequate vitamin A intakes, further strategies are needed to increase the vitamin A intake of all pregnant women in this area.

Key words: Vitamin A intake, 24-hour recall, plant foods, animal foods, pregnancy, socio-economic status, Indonesia

Introduction

Vitamin A is important for many physiological functions, including vision, growth, reproduction, and cell differentiation [1]. Until recently, poor maternal vitamin A status has received attention primarily for its effects on fetal development and child health, e.g., increased risk of preterm birth, reduced intrauterine growth, decreased birth weight [2, 3], and reduced vitamin A content of breast milk [4].

However, recent studies suggest that an improved vitamin A status during pregnancy also benefits maternal health. Vitamin A supplementation during pregnancy has

been found to improve maternal iron utilization and iron status [5, 6], thus benefiting both mother and infant. Poor vitamin A status during pregnancy has been associated with greater risks of severe anemia and a lower body mass index as well as symptoms of urinary/reproductive tract infections, diarrhea, pre-eclampsia, and nausea [7]. Finally, in one study in Nepal, maternal mortality (up to 12 weeks postpartum) was significantly reduced when pregnant women were supplemented with weekly doses of vitamin A [8].

It is not known whether vitamin A intake of pregnant women in Central Java, Indonesia is sufficient. Studies in

the late 80s and early 90s from both West and Central Java have found large proportions of pregnant and early postpartum women to have low to marginal vitamin A status [9, 10]. A recent study of lactating women in West Java found that concurrent micronutrient deficiencies, including vitamin A deficiency, were prevalent [11] and in Central Java a majority of lactating women had an intake below the Indonesian recommended daily intake (RDI) of 800–850 RE for that group. In addition, it has been shown that women's vitamin A intake was associated with their vitamin A status [12, 13].

The aim of the present study was to quantify vitamin A intake among pregnant women in Central Java, Indonesia. In addition, since recent studies suggest a poorer bioavailability of plant sources of vitamin A than previously thought [14, 15], we wanted to elucidate whether the proportions of vitamin A coming from different sources (animal, plant, and fortified) varied among groups with respect to their socio-economic status and total intake of vitamin A. Finally, we wanted to identify risk groups for low overall vitamin A intake.

Subjects and methods

Subjects and sampling design: The study was conducted in Purworejo District, Central Java, Indonesia, which consists of 16 subdistricts and 494 villages. The total population is about 750 000. Since 1994, the Faculty of Medicine at Gadjah Mada University has been operating a Community Health and Nutrition Research Laboratory in the district to support the Ministry of Health of Indonesia in developing and implementing a community health and nutrition surveillance program. A two-stage cluster sampling method was used to select a 10% sample of households representative of the district. The sampling frame for the first stage consisted of a 20 percent sample of the enumeration areas ("wilcah"), developed by the Central Bureau of Statistics for the 1990 census. In the second stage, 101 households were systematically sampled from each of the chosen "wilcahs" [16]. From 1994 to 1998, each household was visited every third month for data collection. To enable early identification of new pregnancies, households with women likely to become pregnant (i.e., married women of reproductive age) were visited monthly. The nutritional status of the total sample of nonpregnant women of reproductive age ($n = 13\,094$) in the area is described in detail elsewhere [17, 18].

Between April 1996 and October 1998, a cohort of 846 women in early pregnancy was recruited for a study on the effect of reproduction on nutritional status. Within this framework, dietary data were obtained (Fig. 1). Unfortun-

nately, the dietary module was not in place initially, and the final data included dietary measurements for one, two, or all three trimesters for a total of 493 women. Thus, the total number of women with dietary data in each trimester did not equal 493, but was 154, 450, and 420 in trimesters one, two, and three, respectively. These data were analyzed cross-sectionally. The reason behind the much smaller sample size in the first trimester was also because the dietary module was not in place initially. Also, some women did not reveal their pregnancy initially. The reasons for exclusion among the remaining 353 women are shown in Figure 1.

Data collection methods: Socio-economic and demographic information for the women were retrieved from the surveillance data collected between August and October 1997. In addition, we used information on home garden activities and livestock ownership that was collected in 1997–1998.

Anthropometry: A portable stadiometer kit (CMS) with an accuracy of 0.1 cm was used to measure body height. Mid-upper-arm circumference (MUAC) was measured on the left arm to the nearest 0.1 cm with insertion-type arm circumference tapes obtained from UNICEF.

Dietary intake: In each trimester, a minimum of three and a maximum of six 24-hour recalls were used to estimate the dietary intake of the individual women. However, for the majority (82%, 90%, and 84% in trimesters one, two, and three, respectively), six recalls were obtained. This number (six) was based on the results of Launer and coworkers [19] on random variation and was expected to estimate individual intake of vitamin A and energy with an error of $\pm 20\%$, an assumption we have confirmed [20]. These replications were randomly distributed among the

Figure 1: Flow-chart of the sample selection.

five different days of the Javanese calendar on nonconsecutive days. The mean $\pm$ SD time lapses between the first and the sixth interview in the first, second, and third trimester were 30 ± 5 , 37 ± 12 and 35 ± 8 days, respectively. Detailed descriptions of all foods, beverages, and vitamin and mineral supplements consumed during the 24-hour period before midnight the previous day, as well as cooking methods, were recorded. Quantities were estimated using seven household utensils and approximately 20 types of food models, e.g., fish, tomato, banana, and meat. The average weight of each type of food equivalent to the portion sizes and fitting into the household utensils were estimated to the nearest gram. Vitamin A values were taken predominantly from the vitamin A content table in de Pee and Bloem [13]. Ninety-two percent of all energy and fat values came from the Indonesian nutrient composition database [21, 22]. The traditional conversion factor of $1 \mu\text{g}$ retinol = $6 \mu\text{g}$ beta-carotene was used [23]. However, when indicated, results are also presented using a conversion factor of 12 now used in the US [24] and 21, suggested by West [25], to be used in low income countries because of helminth infestations and other infections that impair the bioavailability of provitamin A.

The data were collected by 22 trained female interviewers and each respondent was interviewed at home by the same interviewer for all measurements. The interview lasted one to two hours. Data form editing was conducted in the field within a few days and supervisors checked all interviewers periodically. Ethical approval was received from the research ethics committees of the medical faculties of Gadjah Mada University, Yogyakarta, Indonesia, and Umeå University, Umeå, Sweden.

Statistical analyses: Data were analyzed with SPSS/PC statistical software (version 9.0). Chi-square and *t* tests were used to compare the nutritional status and background factors of the selected study sample with those pregnant women not included in the dietary analyses. Univariate logistic regressions were used to examine the relationships between vitamin A intake and other individual characteristics in the second and third trimesters. These were: variables of socio-economic status, variables of nutritional status (height and MUAC), residence, altitude, education, occupation, age, parity, home garden, chicken-raising, energy intake, and vitamin A intake in the previous trimester. Variables significant in the univariate logistic regressions were included in multivariate logistic regressions, where possible associated factors were evaluated simultaneously. The logistic regression analyses were constructed with vitamin A intake as a dichotomous variable (vitamin A intake < FAO/WHO (1988) basal RDI (370 RE) vs. $\geq$ FAO/WHO basal RDI). This cutoff point was selected instead of the Indonesian RDI (700 RE) because

the majority of women were below the latter. Interactions among independent variables likely to show joint effects were evaluated by the construction of a new variable that expressed the combined effect of both. Only significant variables were kept in the final multivariate model (95% confidence interval not including 1).

Results

Characteristics of women: Basic characteristics of the sample women are shown in Table I. The mean SD age of the study sample was 28.8 ± 5.4 years and the mean parity was 1.6 ± 1.4 . Sixty-nine percent of the women had home gardens with vegetables and 86% kept chickens.

Representativeness of the study sample: The sample of 493 women from the pregnancy cohort included in the dietary intake analyses did not differ significantly from those excluded ($n = 353$) with respect to age, parity, height, altitude, residence, education, occupation, type of toilet, or water source ($p < 0.05$). However, a greater proportion of those included in the analyses lived in urban areas (9.5 percent vs. 4.5 percent, $p < 0.01$), and they had a higher MUAC both at two months (25.1 vs. 24.1 , $p < 0.001$) and five months (25.2 vs. 24.4 , $p < 0.001$).

The mean height and age of the total sample of non-pregnant women of reproductive age in Purworejo ($n = 13\,094$) was 149.1 ± 5.1 cm and 30.4 ± 9.7 years, respectively; both statistically different from the study sample ($p < 0.05$). Forty percent of these women had seven or more years of schooling and 39% worked with agricul-

Table I: Basic characteristics of the sample women ($n = 493$)

Characteristic	Mean $\pm$ SD or %
Age (years)	28.8 ± 5.4
Height (cm)	149.9 ± 4.9
Mid-upper-arm circumference at 5 months (cm) (MUAC)	25.2 ± 2.6
Parity (number of children)	1.6 ± 1.4
Education (%)	
0–6 years	56
7–9 years	22
≥ 10 years	22
Urban residence (%)	9
Occupation (%)	
nonagricultural	20
agricultural	39
housewife/unemployed	41
Uses closed latrine (%)	53
Uses water from tap, well or pump (%)	90
Owens home garden with vegetables (%)	69
Owens chickens	86

ture, compared to 44% and 38% in the study sample, respectively ($p > 0.05$). However, a greater proportion, 14%, lived in urban areas ($p < 0.01$) [17].

Vitamin A intake: The median (25th–75th percentile) vitamin A intake in trimesters one, two, and three were 363 (211–595), 427 (232–653), and 430 (254–670) retinol equivalents (RE), respectively. The proportion below the Indonesian RDI of 700 RE for pregnant women was high in all trimesters: 83% in the first trimester, 78% in the second trimester, and 76% in the third trimester. Of the 393 women with measurements in both trimesters two and three, 10% were above and 64% were below 700 RE in both trimesters. Of the 123 women with measurements in all three trimesters, 5% were above and 58% were below in all three. When we used the conversion factors 12 and 21 for beta-carotene to retinol, the proportions above RDI were even smaller, 7–10% and 4–5% in the three trimesters, respectively.

The proportions of vitamin A coming from different sources (fortified, animal, fruits and vegetables) in groups of different total intake (quartiles) are shown in Figure 2. Fruits and vegetables together were the predominant source in all intake groups in all trimesters and their joint contribution ranged from 64% to 79% of the total intake.

Although not statistically significant, there was a trend in trimesters two and three towards a higher proportion of plant sources in the lowest intake quartile compared to the other quartiles (76% in the lowest intake quartile compared to 71–72% in each of the other three). The proportion of vitamin A coming from animal sources ranged between 14–28% in the three trimesters and was constant among the four intake groups. The proportion of vitamin A from fortified sources also did not vary among the intake groups and ranged between 3–13% over time. The main source of fortified vitamin A was instant noodles followed by margarine and condensed milk.

Predicting women at risk of low vitamin A intake

Results from bivariate analyses of vitamin A intake (total as well as from different sources) by women's education level are shown in Table II. In general, the proportion of vitamin A coming from animal foods and fortified sources increased with increasing maternal education and the proportion coming from vegetables decreased. Thus, the differences in total vitamin A intake between the three education groups became even larger when we used conversion factors 12 and 21.

Energy intake increased with higher education level in all three trimesters (Table III). Similar to vitamin A intake, energy intake was lowest in the first trimester and highest in the last one; a trend seen in all education groups. The bivariate associations between vitamin A intake and energy was positive, with the correlation coefficient for vitamin A and energy between 0.38 and 0.40 ($p < 0.001$) in trimesters one through three. Even so, vitamin A density (RE/Megajoul (MJ)) was associated with educational level in the first two trimesters.

Logistic regression models for risk of having a vitamin A intake below 370 RE in trimesters two and three are shown in Tables IV and V. In both these trimesters, the proportion of women consuming < 370 RE was 44%. Not surprisingly, bivariate analyses showed an increased risk for low vitamin A intake with lower energy intake, as well as with a vitamin A intake below basal RDI in the previous trimester. Several indicators of low socio-economic status were associated with an increased risk of low vitamin A intake in both trimesters (lower education level, having a house with a soil floor, and not owning a motor bike). In addition, working in agriculture, not owning a TV, and sharing a toilet with other people were associated with an increased risk in the second trimester. In the third trimester, a height in the lowest quartile (< 146.5 cm) and parity of ≥ 3 children also were associated with a greater risk of a low vitamin A intake. Growing and con-

Figure 2: Proportions of total vitamin A intake coming from the different sources of vitamin A in the different intake groups (quartiles) in trimester 1, 2 and 3.

Table II: Vitamin A intake and proportion from fortified, animal and plant foods by mothers' education levels and trimester

Trimester/Education level	Total intake (RE) ¹ with conversion factor			Source (%) ²			
	6	12	21	Animal	Fortified foods ³	Fruits	Vegetables
Trimester 1							
0–6 yrs (n = 82) ⁴	289 ^a (174–506)	184 ^a (114–299)	130 ^a (84–207)	22	4 ^a	14	60 ^a
7–9 (n = 37)	307 ^a (176–459)	194 ^a (115–324)	164 ^a (84–250)	25	10 ^{ab}	16	49 ^b
≥ 10 yrs (n = 33)	652 ^b (406–944)	429 ^b (262–651)	322 ^b (179–523)	22	15 ^b	15	48 ^b
Trimester 2							
0–6 yrs (n = 250)	322 ^a (196–536)	192 ^a (114–321)	137 ^a (79–221)	19 ^a	3 ^a	13	65 ^a
7–9 (n = 99)	451 ^b (266–778)	306 ^b (183–315)	222 ^b (129–357)	24 ^{ab}	6 ^b	16	54 ^b
≥ 10 yrs (n = 99)	624 ^b (414–902)	406 ^c (293–607)	300 ^c (220–481)	26 ^b	11 ^c	13	50 ^b
Trimester 3							
0–6 yrs (n = 220)	353 ^a (209–602)	206 ^a (131–352)	159 ^a (93–238)	18 ^a	3 ^a	11	68 ^a
7–9 (n = 99)	463 ^{ab} (267–678)	282 ^b (165–446)	219 ^b (121–349)	26 ^b	6 ^b	12	56 ^b
≥ 10 yrs (n = 100)	558 ^b (349–887)	386 ^c (222–571)	267 ^c (170–458)	25 ^b	10 ^c	11	54 ^b

¹ Median (25th and 75th percentile)² Proportion of total intake of vitamin A based on conversion factor 6 µg β-carotene = 1 µg retinol³ Also includes supplements (number of women taking supplements containing vitamin A, n = 2, 4, and 9 in trimester 1–3, respectively).⁴ Values with different superscript letters within a column and trimester are significantly different, *p* < 0.05 (ANOVA and Bonferroni post-hoc test for testing proportions and Kruskal-Wallis and Mann-Whitney *U*-test as post-hoc test for testing medians)

Table III: Energy intake (MJ) and vitamin A intake (RE) per megajoule (MJ), by trimester and education level

Trimester/ Education level	Energy intake (MJ ± SD)	Vitamin A density (RE/MJ ± SD)
Trimester 1		
0–6 yrs (n = 82) ¹	363.6 ^a (1515 ± 507)	60.0 ^a ± 44.6
7–9 (n = 37)	384.7 ^{ab} (1603 ± 564)	57.4 ^a ± 38.6
≥ 10 yrs (n = 33)	446.6 ^b (1861 ± 615)	91.7 ^b ± 45.8
Trimester 2		
0–6 yrs (n = 250)	429.4 ^a (1789 ± 468)	55.0 ^a ± 39.6
7–9 (n = 99)	458.1 ^{ab} (1909 ± 526)	74.9 ^b ± 55.9
≥ 10 yrs (n = 99)	513.8 ^b (2141 ± 505)	77.5 ^b ± 39.1
Trimester 3		
0–6 yrs (n = 220)	451.7 ^a (1882 ± 482)	64.1 ± 72.5
7–9 (n = 99)	473.0 ^{ab} (1971 ± 496)	67.4 ± 45.1
≥ 10 yrs (n = 100)	510.2 ^b (2126 ± 464)	75.8 ± 50.2

¹ Values with different superscript letters within a column are significantly different*p* < 0.05 (ANOVA and Bonferroni post-hoc test)

suming vegetables and owning chickens were not associated with vitamin A intake in either trimester.

In both trimesters, the association between vitamin A intake and education level and total energy intake remained significant after adjusting for other factors. In addition, having no motorbike in the second trimester, and in the third trimester having a vitamin A intake below basal RDI of 370 RE in the previous trimester, remained significant risk factors.

Discussion

This study is one of the first population-based studies to assess vitamin A intake and to identify risk factors for low intake of vitamin A among women followed throughout pregnancy in Indonesia. Our results show that the majority of these Central Java women consume insufficient amounts of vitamin A during pregnancy. The proportion of women below the Indonesian RDI of 700 RE ranged from 83% in the first trimester to 76% in the last trimester, and 58% were below the RDI in all three trimesters. When

Table IV: Statistically significant risk factors for a particularly low vitamin A intake (<basal RDI, 370 RE) in trimester 2 (n = 450)

Risk factor	N	Level	Univariate analyses		Multivariate analyses ³	
			OR ¹	(95% CI ²)	OR	(95% CI)
Vitamin A intake < 370 RE in trimester 1	69	No	1		NA ⁴	
	69	Yes	2.49	(1.24, 5.01)		
Energy intake in trimester 2 in quintiles (kJ)	90	564-highest	1		1	
	90	484-563	2.27	(1.17, 4.40)	1.75	(0.86, 3.55)
	90	420-483	2.61	(1.35, 5.04)	1.91	(0.94, 3.86)
	90	355-419	4.47	(2.32, 8.59)	2.97	(1.48, 5.99)
	90	lowest-354	7.11	(3.65, 13.86)	5.73	(2.79, 11.76)
Education (years)	99	≥ 10	1			
	99	7-9	2.41	(1.29, 4.53)	1.42	(0.70, 2.90)
	250	0-6	4.58	(2.66, 7.87)	2.49	(1.29, 4.81)
Motorbike ownership	87	Yes	1			
	362	No	3.46	(2.00, 5.99)	2.15	(1.10, 4.19)
Television ownership	201	Yes	1	(1.39, 2.99)		
	248	No	2.04			
Type of toilet	199	Private	1			
	251	Nonprivate	1.78	(1.22, 2.60)		
Type of floor	136	Ceramic/tile	1			
	168	Cement/bricks	0.94	(0.59, 1.50)		
	146	Soil	2.01	(1.25, 3.23)		

¹ Odds ratio² Confidence interval³ Includes only those variables which are statistically significant⁴ Because of a much smaller sample size in the first trimester, we did not enter a low intake of vitamin A in trimester 1 in the multivariate model of the second trimester.

Table V: Statistically significant risk factors for a particularly low vitamin A intake (< basal RDI, 370 RE) in trimester 3 (n = 420)

Risk factor	N	Level	Univariate analyses		Multivariate analyses ³	
			OR ¹	(95% CI ²)	OR	(95% CI)
Vitamin A intake < 370 RE in trimester 2	223	No	1		1	
	170	Yes	2.84	(1.88, 4.30)	2.16	(1.36, 3.42)
Energy intake in trimester 3 in quintiles (kJ)	84	582-773	1		1	
	84	523-581	2.49	(1.26, 4.92)	1.88	(0.90, 3.94)
	84	455-522	2.62	(1.33, 5.16)	1.95	(0.94, 4.05)
	84	3.76-454	3.67	(1.87, 7.20)	2.75	(1.31, 5.78)
	84	lowest-375	7.74	(3.87, 15.49)	4.75	(2.24, 10.10)
Height > lowest quartile, 146.5 cm	318	Yes	1			
	101	No	1.64	(1.05, 2.57)		
Parity	346	0-2	1			
	73	≥ 3	2.36	(1.41, 3.97)		
Education (years)	100	≥ 10	1		1	
	99	7-9	1.53	(0.84, 2.76)	1.28	(0.64, 2.56)
	220	0-6	2.83	(1.70, 4.70)	2.26	(1.16, 4.39)
Ownership of Motorbike	82	Yes	1			
	337	No	1.70	(1.03, 2.82)		
Type of floor	130	Ceramic/tile	1			
	157	Cement/bricks	1.45	(0.909, 2.33)		
	132	Soil	1.66	(1.01, 2.71)		

¹ Odds ratio² Confidence interval³ Includes only those variables which are statistically significant

we used the conversion factors of 12 and 21 for beta-carotene derived from plant sources [24, 25], the proportions consuming insufficient vitamin A in the three trimesters ranged from 90–93 and 95–96%, respectively. This is of concern for the women's own health as well as for that of their offspring.

Part of the low vitamin A intake identified could be due to under-reporting. However, the levels of under-reporting of energy intake among these pregnant women were low. For the three trimesters, ratios of mean energy intake/basal metabolic rate were 1.33, 1.53, and 1.52, respectively. The proportion of women classified as under-reporters were 29.7%, 16.2%, and 17.6%, respectively. The high proportion of under-reporters in the first trimester may be explained by an inadequate dietary intake due to reported nausea [26]. Vitamin A intake usually shows large day-to-day variation, which could lead to a selective under-reporting of vitamin A. However, for the majority of the women in our study, six replicate days were used to assess nutrient intake, including market days and holidays when dietary habits may change, and this may have prevented selective under-reporting of vitamin A.

In this article, we did not describe the possible impact of Indonesia's economic crisis, which began in approximately September 1997, on women's vitamin A intake. Preliminary analyses suggest that the mean intake of vitamin A for the whole group did not change over the study period. However, for certain subgroups, such as the urban poor and rural landless women, there was a nonsignificant trend towards a lower intake of vitamin A during the crisis than before it. We will report on these findings in detail in a separate article.

Irrespective of the level of total vitamin A intake as well as education, plant sources constituted the dominant source of vitamin A; 63–79% of all vitamin A came from these sources. These proportions are lower than the 89%, 86%, and 98% reported in previous studies on lactating women in Central Java [12] and South Sulawesi, Indonesia [28], and rural Gambia (including also pregnant women), respectively [27]. However, it is higher than the 53% reported for lactating women in South Kalimantan, Indonesia [28]. Still, women with 10 or more years of education had a higher total intake of vitamin A, a higher vitamin A density, a higher total food intake, a higher intake of vitamin A from animal sources, and three times the consumption of vitamin A from fortificants as women with six or fewer years of education (10–15% compared to 3–4%). Most women in this study consumed noodles, but the consumption of fortified noodles (the major source of fortified vitamin A in this population) was related to education level. Fortified noodles are slightly more expensive than unfortified noodles. In South Sulawesi and South Kalimantan, Indonesia, the consumption of noodles

fortified with vitamin A was also related to socio-economic status [28].

The relationship between education and micronutrient intake during pregnancy has been explored in studies in Northern India [29] and Central Java, Indonesia [30]. In India, the intake of all vitamins except niacin was significantly higher in women with up to eight years of education compared to their illiterate counterparts [29]. De Pee and colleagues also found egg consumption and overall animal sources of vitamin A to increase with education in their study in Central Java [30].

Having a home garden, in earlier studies in Indonesia and Bangladesh, has been associated with a higher intake of vitamin A and a better vitamin A status [12, 31]. Surprisingly, we failed to find any association between vitamin A intake and ownership of a home garden. However, our indicator of household production of plant sources rich in carotene is rather insensitive since many of the vegetables may have been low in carotene. Ownership of chickens, which could lead potentially to a higher consumption of eggs, also was not related to vitamin A intake but was very high at 86%. Also, a social marketing campaign to increase egg consumption in Central Java found that most people purchased the eggs they consumed [30].

As expected, factors associated with low socio-economic status were related to a particularly low vitamin A intake ($<$ basal FAO/WHO RDI, 370 RE). Having a low energy intake, a low vitamin A intake in the previous trimester, a low education level, and not owning a motorbike were all associated with an increased risk of a vitamin A intake below this RDI. A similar trend was seen also for the other socio-economic variables, but these associations were nonsignificant.

What actions can be taken to reduce the number of women with poor vitamin A status? Given the high proportions of women below the Indonesian RDI for vitamin A in all three trimesters, we suggest intervention strategies to reach all pregnant women, rather than targeted interventions. An earlier campaign in Central Java in 1996 that promoted both green leafy vegetable and egg consumption was found to be successful in increasing both vitamin A intake and vitamin A status in the population [30]. However, Melse-Boonstra *et al* [28] believe that the impact of a similar campaign in South Sulawesi and South Kalimantan, Indonesia is likely to be small due to the current economic crisis. These findings indicate the need for strategies less vulnerable to economic fluctuations. Our results and those of Melse-Boonstra and coworkers [28] show that the foods currently fortified with vitamin A do not benefit women of lower socio-economic status. Thus, we agree with Melse-Boonstra *et al* that a better way to provide all population groups access to vitamin A would be fortification of those food items little affected by so-

cio-economic status, such as salt, sugar, or monosodium glutamate (MSG). The latter was the subject of a fortification trial in Indonesia in the 80s and was successful in increasing serum and breast milk vitamin A of children and lactating women, respectively [32, 33]. However, the yellowish discoloration of the MSG was found to be a barrier to acceptability on a wider scale [34].

In conclusion, vitamin A intake was low in this population-based sample of pregnant women studied in Purworejo District, Central Java, Indonesia. Since this group cannot be reached with occasional high doses of vitamin A, it is important to devise strategies that promote an increased dietary intake of vitamin A in all pregnant women, such as fortification.

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