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Nutritional status of lactating women in Bogor district, Indonesia: cross-sectional dietary intake in three economic quintiles and comparison with pre-pregnant women

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Abstract

The way in which women accommodate for their increased nutritional needs during the lactation period is poorly investigated. In a cross-sectional study involving 220 lactating women (LW), equally distributed in economic quintiles (Q2, Q3, Q4), we investigated whether habitual dietary intake of LW differed from that of 200 pre-pregnant women (PPW) studied using the same methodology. Differences in dietary intake and nutrition sufficiency according to economic status were also investigated. Dietary intake data were collected using 2 × 24-h dietary recalls and FFQ. Energy, protein, Fe, Ca, Zn and vitamins A and C intakes were calculated utilising local food composition tables and were compared against Indonesian recommendations for adequacy. Energy and protein intakes <70 % of the recommendation and Fe, Ca, Zn and vitamins A and C intakes <77 % of the recommendation were considered insufficient. Except for Zn, dietary intakes of all studied nutrients were higher in LW compared with PPW. However, for all studied nutrients, dietary intake was insufficient in >25 % of LW. For Q2-LW, this proportion was >50 %, except for protein. LW across all studied economic quintiles approximately doubled their vegetable intake, and 71 % of LW indicated a belief that this enhances lactation performance. Biochemical status parameters were analysed in a subset of forty-five women. Anaemia as well as Fe, Zn and Se deficiencies were prevalent among LW, supporting the nutrient intake deficiency data. Despite increasing intakes in LW compared with PPW, habitual diets in the study area do not provide for daily nutrient requirements in substantial proportions for both LW and PPW across all investigated economic groups.

Key words: **Lactating women: Food intakes: Vegetable intakes: Micronutrient intakes**

The most vulnerable groups for malnutrition worldwide are infants, young children and pregnant and lactating women (LW). Among these groups, actual knowledge about nutritional status and potential nutrient insufficiencies in LW is hardly available. Although the literature on relevant physiological adjustments and additional nutritional requirements is extensive[1,2], the number of dietary assessment studies in LW is limited[3–6]. Thus, the question on whether and how women change their diet upon lactation is far from being answered and is surely also dependent on culture and socio-economic status.

The constant denominator for the actual increased nutritional requirements for LW is the need to produce adequate amounts of breast milk. A variable contribution will be recovery from and replenishment of exhausted nutrient stores after pregnancy and delivery, or an intentional wish to decrease fat stores accumulated during pregnancy[7]. Owing to this variable contribution, several recommendation bodies have made different weightings depending on local or regional factors, and thus arrived at different quantifications of the additional nutrient requirements during lactation.

In this contribution, we specifically report on the dietary survey, nutritional status and selected nutrient status indicators in women exclusively breast-feeding their babies between days 50 and 180 postpartum in Bogor district, Indonesia. To address the question on whether lactating mothers follow a different diet compared with non-LW, we compared the results from LW in three economic quintiles with a group of pre-pregnant

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Abbreviations: HHEQ, Household Expenditure Quintiles; LW, lactating women; MUAC, mid-upper-arm circumference; PPW, pre-pregnant women.

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women (PPW), also described elsewhere in this Supplement[8], using the same methods.

Methods

The present cross-sectional study was conducted in the six sub-districts of Bogor city from August 2010 to August 2011. Ethics approval for the study was granted by the Health Research Institute at the Ministry of Health (no. LB.03.02/KE/6433/2010). The data were collected between January 2011 and May 2011 by study assistants with educational qualification in community nutrition and previous experience in conducting nutritional surveys. They were further trained in the methods utilised in the present study.

The LW and PPW were selected from the integrated community services post (Pos Pelayan Terpadu; POSYANDU) covering the various regions of Bogor district and contacted by study field workers after having obtained permission from the public health centre (Pusat Kesehetan Masyarakat; PUSKESMAS) with equal representation from the six sub-districts: west, north, south, east and central Bogor and Tanah Sareal. Non-pregnant and non- LW in the age group of 20–40 years, not suffering from any chronic diseases affecting their dietary intake pattern, without any acute morbidity conditions on the day of survey, married and not committed to any form of family planning or aware of infertility were considered preparing for pregnancy and were recruited to the PPW group. LW between days 50 and 180 after delivery were recruited to the LW group. This period was chosen considering that breast milk composition is rather constant from 30 d postpartum onwards, and women are recommended to exclusively breast-feed their infant during the first 6 months. Moreover, we assumed that dietary habits to accommodate for the higher requirements during lactation should have been adjusted and stabilised from 50 d postpartum onwards. We did not collect information about previous pregnancies and lactation periods.

Recruitment was done in two steps. In the first screening, the above inclusion criteria were verified, and in the second screening their household expenditure was assessed as proxy information on their socio-economic status. Subjects were classified into the appropriate Household Expenditure Quintiles (HHEQ) of Bogor city[9]. For our study, we selected equal representation from HHEQ-2: 250–330 000, HHEQ-3: 330–430 000 and HHEQ-4: 430–620 000 Indonesian Rupiah (IDR)/capital per month. These levels mainly covered the wider 'middle-income' group, representing 60 % of the households in Bogor district: HHEQ-2, clearly lower-middle income; and HHEQ-4, clearly higher-middle income. A total of 250 LW and 221 PPW were approached to obtain verbal consent to participate in the study; 220 LW and 200 PPW participated in the study. In addition, written consent for blood sample collection in order to assess biomarkers for micronutrient status was obtained from forty-five LW and PPW, equally divided into the three HHEQ.

A semi-structured, close-ended questionnaire was administered to each enrolled woman to elicit information on socio-demographic profile (age, education, occupation and family size), dietary intake and anthropometric profile. Anthropometric measurements of mid-upper-arm circumference (MUAC) and weight were obtained using standard methodology. Validation was carried out during a pre-test with ten LW and PPW, after which the questionnaires and screening forms were finalised. Women with MUAC measurement <23·5 cm were considered as chronically deficient in energy[10,11]. A semi-quantitative FFQ was administered to assess frequency and amount of intake of different food groups during the past 1 week. The frequency of consumption of foods from eight major food groups – (1) cereal and cereal products, (2) meat/poultry and their products, (3) fish and fish products, (4) egg and egg products, (5) milk and dairy products, (6) legumes and their products, (7) vegetable and their products, and (8) fruits and their products – was collected. Indonesian women have a significant intake of intermittent snack foods. Therefore, snacks and beverages were added to the list of the above-mentioned eight food groups; 2-d dietary intake data were collected utilising the 24-h dietary recall method[11]. Total intake was calculated from the dietary intakes using the food composition data from the Indonesian *Food Composition Table* (2004 and 2008)[12,13] or other food composition data (Nutri-survey[14]). All conversions from food intake to nutrient intake were carried out manually using MS excel; diet-specific software was not used. Country-specific nutrient intakes issued in 2004 were considered as reference recommendations[15] for the study group. Our selection to calculate the dietary intakes of energy, protein, Fe, Ca, Zn and vitamins A and C was first based on whether differences in daily intake amount between lactating and non-LW were given in the dietary recommendations. The other criterion for selection was adequate coverage of these nutrients in the local food composition tables. LW with energy and protein intakes <70 % of the recommended levels were classified as having clear deficient intakes[16]. LW with micronutrient intakes (Fe, Ca, Zn and vitamins A and C) <77 % of the recommendations as a proxy for estimated average requirements (EAR) were considered as having 'deficient intakes'[11]. Information about food habits, good foods and food taboos was collected as part of the FFQ. Blood samples (10–12 ml) for biochemical analyses were collected from a subset of women (forty-five LW and PPW each) to assess the Hb level, serum ferritin, serum retinol and plasma Zn. Although Se was not included in the dietary intake calculations because of insufficient coverage of Se in the Indonesian food composition tables, we used the opportunity to add plasma Se to the list of status parameters to at least obtain an impression of the Se status. For logistical reasons, the women were not requested to fast before blood sample collection. Moreover, deficiency cut-off values did not specify on whether subjects needed to have fasted or not. The protocols and methods used are described elsewhere[8].

All data were entered into a database and double checked for any possible keyboard error. Subsequently, data were analysed using SPSS 17.0 for Windows. We used descriptive analyses (percentages, medians and interquartile ranges (IQR) of nutrient) on demographic characteristics including age, education level, household income, income per capita, family size, nutritional status, food consumption and nutrient intake. To compare food consumption and nutrient intake according HHEQ, we first applied ANOVA testing and subsequently compared HHEQ-2 and/or HHEQ-3 with HHEQ-4 using Mann–Whitney U test for non-normally distributed data sets and t test when both data sets were normally distributed; median and IQR levels were reported instead of means and standard deviations because of the wide variability and non-normal distributions in the data. The results were considered to be statistically significant at 5 % level of significance.

Results

All women had at least basic education. Most of them (80 %) were housewives. Education level and family size distribution are given in Table 1. Other background variables such as occupation and education level of the husband, current minor health discomforts and recent infectious diseases were also recorded and provided a similar picture according to differences in socio-economic status. Almost 15 % of the LW were chronically energy deficient based on MUAC (<23·5 cm). This compares with a similar figure of nearly 12·5 % in the PPW. MUAC may be considered as an indicator of nutritional status, independent of body weight, and thus more robust for comparison between PPW, pregnant and LW[10,11]. BMI calculation among the LW revealed that 9 % of them were underweight (BMI <18·5 kg/m^2), whereas nearly 19 % of them were overweight/obese (BMI >25·0 kg/m^2). Among the PPW, the proportion of overweight/obesity amounted to 31 % (Table 1). Approximately half of the LW were exclusively or predominantly breast-feeding their infants (58, 46 and 47 % in HHEQ-2, -3 and -4, respectively), whereas the other half already introduced complementary foods before the age of 180 d.

Both the FFQ and the dietary recall revealed that cereals (mainly rice and their products) and beverages were most abundantly consumed by all women across the HHEQ. Legumes, vegetables and fish consumption was an inherent part of the women's daily diet. On the basis of the FFQ, overall, >70 % of PW reported consumption of these foods and/or their products. Overall, the intakes of eggs and egg products, beverages and particularly vegetables were increased in the LW compared with the PPW (P < 0·05). In HHEQ-2, consumption of legumes and legume products was significantly higher in the LW compared with the PPW, whereas consumption of milk and milk products was lower (P < 0·05). In the other HHEQ, no significant differences for these food groups were found between LW and PPW (Table 2). In the food habits questionnaire, 157 of the 220 (71 %) studied LW indicated that vegetables are particularly suited for their diet because of a perceived effect to enhance the quantity and quality of their breast milk. Among these vegetables, katuk leaves and spinach were most popular as indicated by 109 (50 %) and 84 (32 %) of the LW, followed by papaya leaves (21 %) and papaya flowers (13 %). A statistically significant difference in food group intake among LW according to HHEQ was found for cereals and cereal products, meat and poultry, and milk and dairy products using ANOVA. *Post hoc* tests comparing HHEQ-2 with HHEQ-4 supported the differences for cereals and milk and dairy products (P < 0·05).

Median nutrient intake was clearly higher in the LW compared with the PPW, with statistical significance for all three studied HHEQ for energy and protein and significance for two HHEQ for Fe, Ca and vitamins A and C (Table 3). Comparison within LW among HHEQ revealed statistically significant differences for energy, protein and Ca according to ANOVA. *Post hoc* testing upon comparing HHEQ-2 and HHEQ-4 confirmed this finding (P < 0·05). For Ca and vitamin C, there were significant differences between HHEQ-2 and HHEQ-4 and between HHEQ-3 and HHEQ-4 (P < 0·05).

Relating the median intakes together with the intake levels at the 25th and 75th percentile of LW to the Indonesian RDA[15] revealed information on adequacy of nutrient intake as depicted in Fig. 1 for HHEQ-2 and HHEQ-4. Applying adequacy cut-off values of 70 % of RDA for energy and protein[16] and 77 % of RDA for the other nutrients[11], it can be seen that in HHEQ-2 more than half of LW have too low energy intake, whereas for protein intake this proportion is slightly <50 %. Zn and vitamin A intakes are clearly deficient in more than half, Fe and Ca intakes are deficient in nearly 75 % and vitamin C intake is too low in nearly all HHEQ-2 LW. In HHEQ-4 LW, the nutrient adequacy is clearly better, but here also the majority of the LW do not meet 77 % of the RDA for Fe and vitamins A and C. Moreover, for all of the investigated nutrients, the assumed EAR is not met in >25 % of the HHEQ-4 LW.

Table 4 shows the prevalence of anaemia and Fe, Zn, Se and vitamin A deficiencies in a subset of forty-five PPW and LW, equally distributed according HHEQ-2, -3 and -4. The prevalence of anaemia, Fe deficiency and vitamin A deficiency were slightly higher in LW (not significant). Prevalence of Zn deficiency was significantly lower and the proportion of LW with Se deficiency was higher (P < 0·05, χ^2 test) compared with the PPW.

Discussion

The overall anthropometric profile as an indicator of the nutritional status in LW from our study matches well with that of PPW, used as the control. MUAC as an indicator of protein-energy malnutrition tended to be slightly higher, whereas underweight inferred by BMI <18·5 kg/m^2 was slightly lower. We investigated whether LW with MUAC <23·5 kg/m^2 or BMI <18·5 kg/m^2 actually reported lower energy and/or protein intakes. However, we could not find statistically significant differences. This is probably due to both a limiting subgroup sample size and also a limitation of the cross-sectional design. A longitudinal study would be required to obtain insight into such questions. Overweight + obesity (BMI >25 kg/m^2) seems lower in LW compared with PPW, particularly in HHEQ-2 and -3. Using the χ^2 test, we found significance for HHEQ-3 when comparing the three BMI classes (P = 0·02) and a trend for significance for HHEQ-2 (P = 0·09). Possibly, the negative energy balance during lactation results in weight loss (e.g. reduction of fat tissue accumulated during pregnancy), although a recent longitudinal study in five big Indonesian cities still found higher BMI values in the period from birth till 24 weeks postpartum compared with pre-pregnancy[17]. It should also be noted that overweight + obesity proportion would be clearly higher if BMI >23 kg/m^2 was applied as the overweight + obesity cut-off in Asian populations[18]. With this cut-off level, 47 % of LW in HHEQ-4 have to be classified as overweight + obese. We also performed a subgroup

Table 1. Background characteristics and anthropometric profile of pre-pregnant women (PPW) and lactating women (LW) across socio-economic layers (Household Expenditure Quintiles 2, 3 and 4) (Numbers and percentages; medians and interquartile ranges (IQR))

	Q2				Q3				Q4			
	PPW (*n* 66)		LW (*n* 69)		PPW (*n* 65)		LW (*n* 79)		PPW (*n* 69)		LW (*n* 72)	
Parameters	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Age (years)												
Median	30·0		29·0		30·0		29·0		28·0		28·0	
IQR	26·8; 34·0		25·5; 33·0		24·5; 34·5		25·0; 33·0		26·0; 31·0		24·0; 32·0	
Education												
Primary school	33	50·0	31	44·9	23	35·4	19	24·0	11	15·9	12	16·7
Junior high	15	22·7	18	26·1	19	29·2	24	30·4	14	20·3	18	25·0
Higher education	18	27·3	20	29·0	23	35·4	36	45·6	44	63·8	42	58·3
Family size												
Small (≤4)	46	69·7	26	37·7	51	78·5	42	53·2	57	82·6	40	55·6
Moderate (5–7)	20	30·3	39	56·5	14	21·5	32	40·5	11	15·9	31	43·0
Big (≥8)	0		4	5·8	0		5	6·3	1	1·5	1	1·4
Weight (kg)												
Median	54·0		50·3		52·0		54·0		50·0		52·5	
IQR	48·0; 61·0		46·3; 60·0		47·0; 60·3		49·0; 62·0		45·8; 59·5		48·3; 59·8	
Weight (<45 kg)	11	16·7	9	13·2	9	13·8	4	6·1	11	15·9	7	10·3
Height (cm)												
Median	153		151		152		154		155		154	
IQR	149; 157		147; 157		148; 155		150; 157		149; 157		149; 158	
BMI (kg/m^2)												
Median	23·9		22·2		23·1		23·6		21·7		23·0	
IQR	19·9; 25·7		20·2; 26·0		20·0; 26·0		21·2; 25·4		19·0; 26·1		20·4; 24·9	
BMI classes												
<18·5	9	13·6	7	10·1	6	9·2	5	6·3	11	15·9	8	11·1
18·5–25·0	37	56·1	50	72·5	38	58·5	62	78·5	37	53·6	47	65·3
≥25·0	20	30·3	12	17·4	21	32·3	12	15·2	21	30·4	17	23·6
MUAC (cm)												
Median	27·5		26·0		27·0		26·0		26·4		25·8	
IQR	25·5; 30·0		24·0; 28·0		24·9; 29·3		23·5; 28·0		24·0; 29·0		24·0; 28·0	
MUAC (<23·5)	9	13·6	11	15·9	7	10·8	10	12·7	9	13·0	11	15·3

Q, quintiles; MUAC, mid-upper-arm circumference.

Table 2. Daily intake of different food groups (g) by women across Household Expenditure Quintiles (HHEQ)
(Medians and interquartile ranges (IQR))

	Intakes HHEQ-2				Intakes HHEQ-3				Intakes HHEQ-4			
	PPW		LW		PPW		LW		PPW		LW	
Food groups	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR
Cereals and products	451	320; 533	483	363; 608	523	358; 678	537	469; 708	504*†	399; 655	617*‡	485; 728
Meat/poultry and products	45	30; 98	60	37; 94	69	45; 107	76	46; 110	90*‡	45; 149	90*	45; 136
Fish and products	24	13; 33	30	14; 46	26	13; 34	27	15; 43	26	13; 47	27	14; 44
Egg and products	39	22; 58	35	22; 61	34	22; 52	55§	39; 77	39	28; 50	42§	22; 77
Milk and dairy products	240	121; 242	178§	121; 279	174	121; 279	239	121; 268	242	149; 257	211*‡	120; 250
Legumes and products	78	39; 101	105§	58; 167	78	42; 122	109	40; 174	59	39; 102	78	39; 176
Vegetables and products	97	48; 176	246§	147; 320	145	93; 250	217§	135; 316	136‡	79; 237	223§	138; 331
Fruits and products	80	47; 108	87	68; 265	75	47; 86	130	48; 170	95	47; 270	84	47; 131
Beverages	1090	894; 1444	1210	900; 1600	1000	750; 1296	1200§	939; 1600	1000	850; 1371	1298§	925; 1600
Snack foods	79	30; 118	68	30; 122	62	39; 111	73	30; 152	75	40; 134	76	34; 133

PPW, pre-pregnant women; LW, lactating women.
* Statistically significant trend according to HHEQ ($P<0.05$) using ANOVA test.
† Statistically different between Q2 and Q4 ($P<0.05$) using *t* test.
‡ Statistically different between Q2 and Q4 women ($P<0.05$) using Mann–Whitney *U* test.
§ Statistically different between LW and PPW ($P<0.05$) using Mann–Whitney *U* test.

Table 3. Nutrient intakes of lactating women (LW) and pre-pregnant women (PPW) across Household Expenditure Quintiles (HHEQ)
(Medians and interquartile ranges (IQR))

		HHEQ-2				HHEQ-3				HHEQ-4			
	AKG PPW/LW	PPW		LW		PPW		LW		PPW		LW	
Nutrients	Median	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR
Energy (kJ)	7531–7949/9832–10 250	5125	4196; 6288	6569	5004; 8547	5635	4443; 6974	7146	5865; 9012	6556	5119; 8146	7861	7757; 9489
Energy (kcal)*	1800–1900/2350–2450	1225	1003; 1503	1570†	1196; 2043	1347	1062; 1667	1708†	1402; 2154	1567‡§	1222; 1947	1879†‡§	1854; 2268
Protein (g)	50/67	38	32; 44	50†	37; 64	43	34; 56	54†	42; 71	52‡‖	39; 64	61†‡§	46; 77
Fe (mg)	26/32	15	11; 19	20†	14; 25	16	13; 21	21†	16; 27	17‖	12; 24	19	14; 29
Ca (mg)	800/950	453	254; 574	558†	437; 768	485	362; 733	617†	421; 944	587‡‖	346; 942	803‡¶	542; 1092
Zn (mg)*	9·3–9·8/13·9–14·4	9	5; 13	10	6; 16	11	8; 16	13	7; 18	11‖	7; 17	12	8; 17
Vitamin A (RE)	500/850	207	66; 410	432†	162; 733	216	66; 528	421†	137; 691	438‖	185; 738	517	258; 891
Vitamin C (mg)	75/120	8	3; 19	18†	7; 53	12	3; 38	20	8; 41	14‖	8; 39	36†¶	16; 94

AKG, Angka Kecukupan Gizi (country-specific nutrient recommendations for Indonesia).
* Requirements for energy and Zn are age specific.
† Statistically different between LW and PPW ($P<0.05$) using Mann–Whitney *U* test.
‡ Statistically significant trend according HHEQ ($P<0.05$) using ANOVA test.
§ Statistically different between Q2 and Q4 women ($P<0.05$) using Mann–Whitney *U* test.
‖ Statistically different between Q2 and Q4 ($P<0.05$) using *t* test.
¶ Statistically different between Q2 and Q4 and between Q3 and Q4 ($P<0.05$) using Mann–Whitney U test.

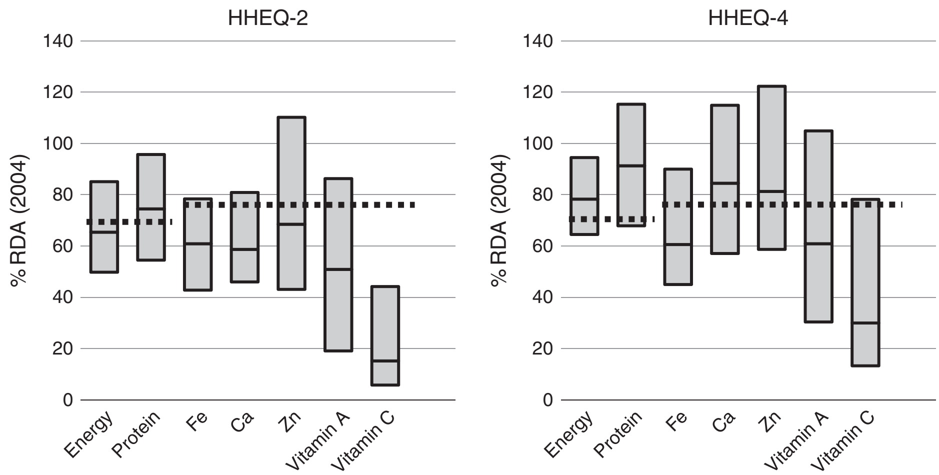

Fig. 1. Nutrient intake range plots (medians, 25th, 75th percentiles) in Household Expenditure Quintiles (HHEQ)-2 (left) and HHEQ-4 (right) among lactating women as percentage of Indonesian RDA (2004). ············, Represent 70 and 77 % of energy and protein and other nutrient RDA, respectively, as (in)sufficiency indicator.

analysis by comparing dietary intake of overweight + obese women with women having BMI <25 kg/m^2, but failed to find statistically significant differences, most likely because of the limitations already mentioned for underweight and/or malnourished women.

Overall energy and protein intakes were higher in LW, whereas statistical significance of the difference in consumption of relevant food groups could only be demonstrated for beverages, vegetables and eggs and egg products. In particular, the nearly doubling of vegetable intake among LW was remarkable. A major reason for this increase was indicated by LW that vegetables helped in increasing the quantity and quality of breast milk, although there is little scientific evidence for this perception. Among the vegetables, katuk leaves were most popular for their perceived function as a lactation-enhancing food. Dietary consumption of katuk leaves, also known as chekor manis[19] or *Sauropus androgynous*, is rather common in South East Asia and is nutritionally interesting because of its flavonoid and antioxidant activity[20] and its rather high protein content for a leafy vegetable[19]. However, high consumption of juice from uncooked katuk leaves in Taiwan was associated with an outbreak of bronchiolitis obliterans syndrome[21]. So far, the alkaloid ‘papaverine’ is considered to be the main component associated with this safety risk and it is unclear whether various local varieties or katuk strains are comparable with respect to its content. In our study, thirty-one of the 220 (14 %) LW consumed katuk leaves at least once during the two 24-h recalls, with one subject consuming it at both days, reporting a total intake of 1116 g. The median katuk intake among the katuk users on one of both assessment days was 344 g and there was no trend in different consumption pattern across the HHEQ. Although these intakes are similar to those listed in the report from Taiwan[21], Indonesian women consumed katuk leaves nearly always cooked (stir fried or boiled) and rarely at a high frequency. This probably explains the absence of any safety concerns, and although its lactation-enhancing properties remain largely unproven, its nutritional adequacy is well established[19,20]. The higher consumption of vegetables by LW compared with PPW is the main driver for the observed significant differences in vitamin A and C intakes in Table 3 between LW and PPW in HHEQ-2 and -3 and HHEQ-2 and -4, respectively. This is also illustrated by the observation that in LW 66 % of vitamin A intake and 73 % of vitamin C intake originated from vegetables, mainly leafy vegetables. The corresponding proportions for PPW were 43–41 %, respectively. We found a higher mean serum retinol level among LW compared with PPW, 56·7 (SD 28·8) *v.* 49·8 (SD 21·88) mg/dl, but the difference was not statistically significant ($P = 0·2$); it would have needed larger subgroups (>107subjects/group) willing to provide blood samples to reach significance at the 5 % level.

The priority nutrients for LW to ensure adequate levels for excretion in breast milk are vitamins A,-B_1,-B_2,-B_6,-B_{12} and I[3,4]. This probably holds true for both developed and developing countries with a lack of information from data of South East Asia[22]. Among the priority nutrients, we find that the intake of vitamin A in more than half of our LW is below the level of sufficiency in both HHEQ-2 and HHEQ-4, which is a clear argument to continue the successful vitamin A infant and young children supplementation programme in Indonesia. The concentration of Ca excreted by LW via their breast milk is remarkably constant and not dependent on dietary intake. Thus, Ca excretion during lactation is mostly higher than the dietary intake, and as a consequence Ca is mobilised out of the woman’s bone leading to a decrease in bone mineral mass. For both Western women with fairly high Ca intakes and non-Western women with fairly low Ca intakes, this process has been shown to be fully reversible and it has been suggested that it is a normal physiological response to lactation[23,24]. Thus, Ca is not considered as a critical nutrient for LW and supplementation is not needed. In contrast, O’Brien *et al.*[25] suggest that it is desirable for LW with Ca intake <500 mg/d to increase its intake, preventing a negative balance in bone Ca turnover during pregnancy and lactation. From the IQR of Ca intake in our study (Table 3), >25 % of the LW in both HHEQ-2 and HHEQ-3 had Ca intakes <500 mg/d; in HHEQ-4 LW, this proportion was somewhat <25 %. Thus, a substantial

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Table 4. Biochemical analyses of the blood samples collected

		Pre-pregnant women (*n* 45)	Lactating women (*n* 45)
Parameters (indicators)	Cut-off	Prevalence (%)	Prevalence (%)
Anaemia (Hb level)	<120 g/l	11·1	17·8
Fe deficiency (serum ferritin)	<15 μg/l	23·1*	27·9*
Vitamin A deficiency (serum retinol)	<200 μg/l	6·7	11·1
Zn deficiency (plasma Zn)	<65 μmol/l	42·2	24·4†
Se deficiency (plasma Se)	<0·75 μmol/l	4·4	28·9†

* For serum ferritin determination, *n* 39 for pre-pregnant women and *n* 36 for lactating women.
† Statistically different between lactating and pre-pregnant women according to χ^2-test ($P<0·05$).

proportion of LW would benefit from dietary changes, resulting in higher Ca intakes.

The biochemical markers for micronutrient deficiencies that could be measured in a subsample of our LW confirmed the results of the nutrient intake analysis. We found very little overlap between LW with Hb and ferritin levels below the cut-off values, and thus a very low proportion of Fe-anaemic subjects; however, the combined proportion of LW with either anaemia or too low ferritin amounting up to 45 % remains a reason for concern. The lower proportion of LW with plasma Zn below the adequacy cut-off value compared with the PPW (24 *v.* 42 %) may be related to the higher protein intake in the LW; because of the low numbers, we did not attempt to make comparisons between these status parameters and actual nutrient intakes. An explanation for the higher proportion of LW with Se levels below the normal value might be a higher demand for Se during lactation. As food composition tables relevant for Indonesia provide insufficient data for Se, we could not calculate the dietary intake of Se. Recent data from a survey in Fuijan province, China, revealed mean dietary Se intakes well above the Chinese reference nutrient intake (RNI)[5], but it is well established that there is substantial regional variability in the Se composition of foods[26].

The cross-sectional design and reasonable number of subjects well distributed in each of the three HHEQ are the major strengths of this study. Unfortunately, intake information for several relevant nutrients (e.g. dietary fibre, fat quality, DHA, Se) could not be calculated because of limited data in the currently available country-specific food composition tables. Only qualitative information on the intake of supplements was obtained, and thus it was not possible to calculate nutrient intake from diet + supplements of the women. This is a clear limitation and should be addressed in future studies. Furthermore, biochemical estimations could be performed for only a limited number of women due to both study logistics and cultural reasons among the women. Nevertheless, there is reasonable agreement between both approaches, indicating little selection bias, if any. Other limitations include lack of information about the women's physical activity level or access to healthcare professionals with knowledge of nutrition, which may account for some observed differences. We also did not collect information about previous pregnancies and their spacing, which might influence the risk for suboptimal nutritional status. Although they are currently the most frequently used methods in dietary intake studies, routine FFQ and 24-h intake analyses are not gold standard methods[11]. The non-normal distribution of most data sets for food group intake and also nutrient intake did complicate the statistical analyses. Data transformation turned out to be an unsuitable option to induce normality as we lost all contrast. Therefore, the initial analyses across the HHEQ were still carried out using ANOVA, combined with *post hoc* comparisons between HHEQ-2 and HHEQ-4 using appropriate non-parametric tests. We did not perform a dedicated analysis on potential misreporting, but in the accompanying paper[8] we provide arguments that energy intake values in the range between 25th and 75th percentile are physiologically plausible.

Conclusion

Our study showed that LW changed their diet to partly accommodate for the higher nutrient requirement during lactation. However, overall, in more than half of the LW, nutrient intakes considered to be minimally needed were not being met. The spectrum of deficient nutrient intakes was similar across the studied socio-economic classes. However, the proportion of women with marginal intakes clearly decreased, from lower (HHEQ-2) to upper middle class (HHEQ-4). Nevertheless, in the upper middle class as well, >25 % of the LW had a deficient intake. Although the messages and their emphasis may be somewhat different for the various socio-economic classes, more nutrition education is needed across all classes to increase understanding of nutrient requirements during this specific stage in life.

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References

1. World Health Organization (2012) Nutrition of women in the preconception period, during pregnancy and the breastfeeding period. Nutrition, Report by the Secretariat. Geneva: WHO. http://apps.who.int/gb/ebwha/pdf_files/WHA65/A65_12-en.pdf (accessed February 2016).
2. Picciano MF (2003) Pregnancy and lactation: pysiological adjustments, nutritional requirements and the role of dietary supplements. *J Nutr* **133**, 1997S–2002S.
3. Allan L (2005) Multiple micronutrients in pregnancy and lactation: an overview. *Am J Clin Nutr* **81**, Suppl. 1, 1206S–1212S.
4. Hall Moran V, Lowe N, Crossland N, *et al.* (2010) Nutritional requirements during lactation: towards European alignment of reference values: the EURECA network. *Matern Child Nutr* **6**, Suppl. 2, 39–54.
5. Chen H, Wang P, Han Y, *et al.* (2012) Evaluation of dietary intake of lactating women in China and its potential impact on the health of mothers and infants. *BMC Women's Health* **12**, 18.
6. Kajale NA, Khadilkar VV, Mughal Z, *et al.* (2015) Changes in body composition of Indian lactating women: a longitudinal study. *Asia Pac J Clin Nutr* (Epublication ahead of print version September 2015).
7. Benedict Griffin P (2008) Maternal nutrition during lactation. In *California Food Guide: Fulfilling the Dietary Guidelines for Americans*, Chapter 8, pp. 1–28 [S Williams, editor]. Sacramento, CA: California Department of Health Care and California Department of Public Health. http://www.dhcs.ca.gov/formsandpubs/publications/CaliforniaFoodGuide/8Maternal-NutritionduringLactation.pdf (accessed February 2016).
8. Madanijah S, Briawan D, Rimbawan R, *et al.* (2016) Nutritional status of pre-pregnant and pregnant women residing in Bogor district, Indonesia: a cross-sectional dietary and nutrient intake study. *Br J Nutr* (epublication ahead of print version 15 April 2016).
9. Badan Pusat Statistik (2010) SUSENAS 2009 JAWA BARAT (Indonesian National Social Economic Survey 2009). Bandung: Direktorat Diseminasi Statistik, Subdirektorat Layanan dan Promosi Statistik.
10. Sebayang SK, Dibley MJ, Kelly PJ, *et al.* (2012) Determinants of low birthweight, small-for-gestational-age and preterm birth in Lombok, Indonesia: analyses of the birthweight cohort of the SUMMIT trial. *Trop Med Int Health* **17**, 938–950.
11. Gibson R (2005) *Principles of Nutritional Assessment*, 2nd ed. New York: Oxford University Press.
12. Ministry of Health (Indonesia) (2004) *Daftar Komposisi Bahan Makanan (Food Composition Table)*. Jakarta: Kementerian Kesehatan RI.
13. Mahmud MK-H, Zulfianto NA, Apriyantotono RR, *et al.* (2009) *Tabel Komposisi Pangan Indonesia (Indonesian Table of Food Composition)*. Jakarta: PT Elex Media Komputindo.
14. Southeast Asia Ministers of Education Organisation (SEAMEO), University of Indonesia (2005) Nutrisurvey for Windows Database. http://www.nutrisurvey.de/databases/indones.ZIP (accessed February 2016).
15. Ministry of Health (Indonesia) (2004) *Angka Kecukupan Gizi Indonesia (Indonesian Recommended Dietary Allowances)*. Jakarta: Kementerian Kesehatan RI.
16. Ministry of Health (Indonesia) (1996) *13 Pesan Dasar Gizi Seimbang (13 Messages on Balanced Diets)*. Jakarta: Direktorat Bina Gizi Kesehatan Keluarga, Kementerian Kesehatan RI.
17. Fikawati S, Syafiq A, Kusharisupeni, *et al.* (2014) Comparison of lactational performance of vegetarian and non-vegetarian mothers in Indonesia. *Mal J Nutr* **20**, 15–25.
18. Low S, Chin MC, Ma S, *et al.* (2009) Rationale for redefining obesity in Asians. *Ann Acad Med Singapore* **38**, 66–74.
19. Voon BH & Siong KH (1999) The nutritional value of indigenous fruits and vegetables in Sarawak. *Asia Pac J Clin Nutr* **8**, 24–31.
20. Andarwulan N, Batari R, Sandrasari DA, *et al.* (2010) Flavonoid content and antioxidant activity of vegetables from Indonesia. *Food Chem* **121**, 1231–1235.
21. Ger LP, Chiang AA, Lai RS, *et al.* (1997) Association of *Sauropus androgynous* and bronchiolitis obliterans syndrome: a hospital based case-control study. *Am J Epidemiol* **145**, 842–849.
22. Talavera MA, Tuazon MAG & Felix AdR (2013) Young child and maternal nutrition: a review of the situation in the SEA region. *JNDAP* **27**, 53–69.
23. Prentice A, Jarjou LMA, Cole TJ, *et al.* (1995) Calcium requirements of lactating Gambian mothers: effects of a calcium supplement on breast milk calcium concentration, maternal bone mineral content, and urinary calcium excretion. *Am J Clin Nutr* **62**, 58–67.
24. Laskey AM, Prentice A, Hanratty LA, *et al.* (1998) Bone changes after 3 mo of lactation: influence of calcium intake, breast-milk output, and vitamin D-receptor genotype. *Am J Clin Nutr* **67**, 685–692.
25. O'Brien KO, Domangelo CM, Vargus Zapata CL, *et al.* (2006) Bone calcium turnover during pregnancy and lactation in women with low calcium diets is associated with calcium intake and circulating insulin-like growth factor 1 concentrations. *Am J Clin Nutr* **83**, 317–323.
26. Food and Agriculture Organization of the United Nations (2001) Selenium. In *FAO/WHO Expert Consultation on Human Vitamin and Mineral Requirements*, Chapter 15, pp. 235–255 [G Nantel and K Tontisirin, editors]. Rome: Food and Nutrition Division, FAO. http://www.fao.org/docrep/004/y2809e/y2809e0l.htm (accessed February 2016).