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ORIGINAL ARTICLE

ZINC STATUS OF YEMENI PREGNANT WOMEN AND ITS EFFECTS ON THE OUTCOME OF PREGNANCY

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ABSTRACT

Background: *Micronutrients are essential for health.Pregnancy is associated with increased demand for all micronutrients. Altered plasma levels of zinc during pregnancy are known to have profound effects on pregnant women and their newborns. The objective of the study is to assess serum zinc status of Yemeni pregnant women and their newborns and to examine its relations.*

Methods:*This is a descriptive cross sectional study that was carried at Al-Sabeen maternal referral hospital in Sana'a. It included 184 subjects, 92 Yemeni pregnant women coming for delivery and their newborns.A questionnaire was used to collect personal, socioeconomic data and dietetic history. Blood samples from mothers and umbilical cord were analyzed for serum zinc.*

Results: *Most of the mothers (91.3%) were housewives; 34.78% of them were illiterate. Carbohydrates were the predominant nutrients in the daily meals representing the main source of energy requirement. Proteins were the least abundant. Only 36.96%of mothers used vitamins and mineral supplements. The mean serum zinc for the mothers was 68.57 ± 21.81 µg/dL, while that of their newborns was 65.05 ± 20.04 µg/dL. The mean of the newborns' weight was 2.8 ±0.47 kg. It was significantly related to their mothers' serum zinc levels.*

Conclusions: *Zinc status of newborns was found to be significantly related their mothers'. Serum zinc was low in about 44% of newborns indicating inadequacy of zinc transfer during pregnancy to the rapidly growing fetus. Supplementation, nutritional education and counseling may improve dietary intake and habits which is crucial for maternal and newborn health.*

Keywords: *Zinc status, pregnant women,newborns,micronutrients.*

INTRODUCTION

Nutrients consist of macro- and micronutrients. Micronutrients include vitamins and some minerals; they are essential for health, and generally are needed in minute quantities (<1gm/d). They are usually absorbed unchanged and many have catalytic functions [1]. Trace elements are those required in diet and found in tissues in minute amounts [2,3].

Micronutrient deficiencies, a significant cause of malnutrition, are associated with ill-health among populations in developing countries [4]. The deficiency of these nutrients results from inadequate intakes, impaired absorption and/or utilization, excessive losses, or a combination of these factors and are exacerbated during times of greeter physiological need such as infancy, adolescence and pregnancy [5].

Pregnancy is associated with increased demands for all micronutrients like iron, copper, zinc, vitamin B12, folic acid and ascorbic acid; and deficiency of any of these could affect pregnancy, delivery and outcome of pregnancy[6].

Zinc deficiency was noticed for first time in 1040 in malnourished Chinese adults; three decades later in adolescent farmers from Iran and Egypt.Eventually following its deficiency in various age groups of many countries considered a significant public health problem [7].

Clinical symptoms attributed to chronic zinc deficiency include impaired immunity, increased susceptibility to infections, poor wound healing, persistent skin disorders, poor growth and male infertility [8].

There are increased zinc needs during pregnancy, which could be met by an increase in zinc intake or by adjustments in zinc homeostasis. Because women do not typically increase their zinc intake during pregnancy and lactation, adjustments in zinc absorption, excretion, tissue distribution, or all must occur to meet these greater demands for zinc [9].

Serum zinc is the most widely used index of zinc status in humans. Serum zinc is measured by several methods including flame atomic absorption spectrometry (FAAS), but it has disadvantages of high costs, high matrix effects and expensive equipment. Spectrophotometric method, however has the advantage of low cost of equipment and procedures are suitable for clinical and laboratory investigations even in small laboratories [10].

This study aimed to assess socioeconomic state, life style and dietary habits and reproductive health characteristics

of Yemeni pregnant women; and to examine their serum zinc status as well as their newborn babies and its relations.

METHODOLOGY

This is a descriptive cross sectional study that was carried on 184 subjects, 92 Yemeni pregnant women coming for delivery to Al-Sabeen referral hospitaland their newborns during the period from November 2008 through February 2009. Al-Sabeen H is the main governmental referral hospital for maternity and childhood in Sana'a city-Yemen. We excluded those who had chronic infectious or chronic diseases; malarial infections, obstetrical abnormalities or diseases complicating pregnancy; and those who not willing to participate.

After explanation of the nature of the study for the subjects and obtaining their consent, they were submitted for the following procedures:

1) Questionnaire:

Identification data**,** socioeconomic and dietetic history as well as present, and past medical history were taken through a designed questionnaire.

2) Clinical examinations:

Complete physical examination was performed for mothers. At the delivery:

a- Birth events were assessed (including duration of pregnancy, progress and type of labor; and pre or post-partum hemorrhage).

b- The newborns were assessed for birth weight and the Apgar score; and for congenital anomalies.

3) Laboratory investigations:

Blood samples (7.5mL) were collected from antecubital vein of the mothers using non-heparinized tube-syringes. Cord blood was taken from the maternal end of the umbilical cord [6]; 5mL of the sample was put in a trace element-free vacutainer without anticoagulant. Serum was separated using trace element free techniques [11]. Each serum sample tube was wrapped with foil then with labeled sticker and transferred to the rack in an ice box. The samples were then stored at –20C^{0}till analyzed[12].

Serum samples were then transported to the laboratory in the National Centre for Researches in Cairo city-Egypt in coolers fitted with frozen ice packs and analyzed for zinc. FAR kit for zinc determination calorimetrically in serum was used without deproteinization according to [13,14]. Reference values:68.0- 107.0µg/dL (10.4- 16.4µmol/L).

All data collected throughout history and laboratory investigations were coded and entered into the computer and analyzed with SPSS version 16. Univariate and multi-variate analysis; Pearson correlation coefficient and chi-square were used to analyze the data. Paired samples statistic was done using independent samples t-test. Results were expressed as correlation coefficient (r) and statistical significance of the relationship at 95% confidence interval (p> 0.05). Categorical data were also interpreted using Pearson Chi-Square tests for the relationship between maternal and newborn parameters.

RESULTS

This is a part of a larger study that was designed to determine the micronutritional status of Yemeni pregnant women and its effects on the outcomes of pregnancy.

The study included 92 Yemeni pregnant women coming for delivery at Al-Sabeen referral hospital during the period of study and their newborns. The age of the mothers ranged from 18- 40 years with a mean of 25.96 years; 77 (83.7%) of them were in the range of 20- 34years. However, 22 (23.91%) of them had married before the age of 18 years. Furthermore, 84 (91.3%) were housewives and3(3.26%) were employees.

Total incomes of the families ranged between 30,000 to 100,000 YR with a mean of 47,766.67± 19, 512.05YR. Moreover, 61 (66.3%) of them had low income according to. [20]

Regarding the educational state of the mothers, 32 (34.78%) of them were illiterate and 26 (28.26%) had primary education. There was statistically significant relation between maternal educational state and their newborns' serum zinc levels (p= 0.029) (Table 1).

Furthermore, 62 (67.39%) of the mothers didn't practice the qat-chewing habit (takhzeen), and 22 (23.91%) chewedqat once per week. Maternal qat-chewing was significantly related to their serum zinc levels (p= 0.015); but not to their newborns' (Table 2).

Regarding dietetic style characteristics, high energy protein-poor foods like bread and rice were taken more frequently by mothers, 79 (85.87%) of them took bread containing meals. Beans were taken 2-3 times daily by 49 (53.26%) mothers, while 59 (64.13%) mothers got dairy products once daily. Animal protein rich foods such as meat, chicken, and eggs were used weekly by most mothers. Thirty two mothers (34.78%) didn't take fish at all, while 59 (64.13%) of them took fish once weekly. Servings of vegetables were taken once daily by 89 (96.74%) mothers, while fruits were taken once weekly by 50 (54.35%) mothers (table 3). Vitamins and mineral supplements were used during pregnancy by36.96% (n=34) of the mothers.

Number of pregnancies among mothers ranged between 1 and 10. Moreover, 59 (64.13%)of the mothers were either primigravida or para two; while 19(20.65%) had pregnancies 3-5 times; and 14 mothers (15.22%) were multigravida of more than 5 times. Nineteen (20.65%) of mothers had history of abortions once. Spacing between births ranged between minimal periods of ten months to maximal period of 7 years; with (40.58%)of mothers had spaced by 2 to 3 years; while birth spacing time of less than two years were encountered among 26.1% of them.

The mean of the newborns' birth weight was 2.8 ±0.47 kg. Besides, 75 (81.52%)of the newborns were with birth weight of 2.5kg or more, while 17 (18.48%) of them weighed less than 2.5kg at birth. Newborns' birth weight was significantly related to their mothers' serum zinc level (p = 0.033) (Table 4).

Serum zinc of 89 mothers and 84 newborns were analyzed (due to loss of some samples). The mean serum zinc for the mothers was 68.57 ± 21.81 µg/dL, while that of their newborns was 65.05 ± 20.04 µg/dL. Cut off values for both mothers & newborns = 68.0- 107.0 µg/dL (10.4-16.4µmol/L) [13]. Moreover, 54 mothers (60.67%) had normal serum zinc levels and 30 mothers (33.71%) had less than normal. Serum zinc levels were within the normal range in 45 (53.57%) of the newborns; less than normal in 37 (44.05%) of them. There was statistically significant relation between mothers' and their newborns' serum zinc levels ($p< 0.001$) (Table 5).

DISCUSSION

Micronutritional status is one of many factors that have direct impacts on pregnancy and pregnancyoutcomes. Requirements for many micronutrients increase during pregnancy. Deficiencies can exist because of losses or malabsorption associated with disease or inadequate intakes, lack of knowledge about adequate nutrition, habitual dietetic behaviors or dietary taboos associated with pregnancy with potential adverse consequences for both mothers and newborn infants [15,16].

Our findings showed that most of the mothers (91.3%) were housewives, only (n = 3, 3.26%) were employees, (n = 2, 2.17%) were teachers and similar number were free workers and one was a student. Our finding was nearly similar to Al-Kaaky, 2004 [17], who found that 86.5% of mothers were housewives in a study conducted in Aden city. Significant reduction in birth weight and preterm labor has been reported to be associated with fatigue, prolonged standing, heavy lifting or carrying load with physical exertion[18]. However, activities of some housewives at home may be to great degree of strenuousness and stressfulness, especially in suburban or rural areas, but this need further expanded controlled studies.

Monthly income was categorized into: low (< 50000YR), moderate (50000YR-100000 YR) and high (> 100000YR). Most of the families (66.3%) had low income according to [19,20]. Family income was estimated according to monthly income or calculated from daily income. Total income of the families were not significantly related neither to maternal nor to their newborns' parameters; this may be attributed to the fact that the mothers' and husbands' jobs per se do not reflect the exact income of the family because there are many confounding factors that might affect family income such as assistance from relatives, fluctuating economic and non-fixed prices especially food items. Another study had established strong relation between socioeconomic disadvantages and low birth weight, as it impairs fetal development by causing greater physical and psychological stress, lower educational level, inadequate housing, and by limiting access to medical care and to nutritious foods [21].

Our study showed that 34.78% of mothers were illiterate. This was less than that reported by Christopher, 2009 [22] who reported that the national literacy rate in Yemen was about 50 percent; with female illiteracy near 70%. Al-Kaaky, 2004 also found that 69.6% of mothers were illiterate in a study conducted in Aden city [17]. There was statistically significant relation between maternal educational state and their newborns' serum zinc level ($p= 0.029$) (Table 1). This may be attributed to the higher bioavailability of dietary zinc of the educated mothers; educational level usually determines the economic condition of the family and hence more chance for access to supply of foods rich in different micronutrients. Programs to improve pregnancy outcome should include promotion of maternal literacy, and early and regular antenatal care [23].

Chewing qat (takhzeen al-qat), a psychotropic plant, is a deeply rooted addictive habit in Yemeni society. Qat has been cultivated for use as a stimulant for centuries in Yemen, other parts of the Arabian peninsula as well as the horn of Africa [24,25]. In the present study, we found that most of the mothers (67.39%) do not practice this habit. This finding was approximately consistent with other studies [17, 26]. But, another study estimated that about 80% of Yemeni men and 60% of Yemeni women chew qat[25]. Qat has psychological, medical, social and economic effects on human beings [24]. Maternal qat-chewing habit was significantly related to their serum zinc level ($p= 0.015$); but not to their newborns'.

Nutrition is highly dependent on economic status, social and cultural environment, and personal habits of the mother [27]. Some studies found a significant association between qat chewing during pregnancy and reduction of birth weight [28, 29]. This may be related to the alkaloid cathinone and other qat ingredients that affect mother appetite and placental circulation.

High energy, protein-poor foods like bread and rice were taken more frequently by mothers, 85.87% of them had bread containing meals 2-3 times daily. Yemeni meals in this pattern revealed that carbohydrates were the predominant nutrients in the habitual daily consumed meals and they were the main source of energy requirement. Vegetables and fruits (which are rich in vitamins and minerals) were consumed less frequently, especially fruits which were taken once weekly by most of the mothers. Proteins of high biological value were the least abundant.

The current results provide further support to studies indicating that prices of fruits and other nutritional elements are a barrier to consumption by low-income consumers, so developing public policies to make these nutrients more affordable for low-income families should be encouraged [30,31].

Maternal nutrition is highly associated with fetal growth and birth size[32,33], especially in the developing countries, where malnutrition is common among considerable percentage of population [34].

Spacing between births ranged between minimal period of ten months to maximal period of 7 years. Most of the mothers (40.58%), separated between births by period of 2 to 3 years. Our findings showed that spacing between

births was not significantly related to the newborns' birth weights. Several authors, however, reported a significant relationship between short interpregnancy interval and low birth weight, either preterm delivery or intrauterine growth retardation and perinatal and infant mortality [28,35].

The mean of the newborns' weight was 2.8kg ±0.47. Most of the newborns (81.52%) were with birth weight of 2.5kg or more, while only18.45%weighed less than 2.5kg, low birth weight (LBW). Newborns' birth weight was significantly related to their mothers' serum zinc level (p = 0.033). Our finding of mean birth weight was less than that reported by Al-Asbahi, 2004 in Aden city that was 3.1kg [28]. The overall percentage of LBW in our study (18.45%) was more than that reported in that study (9.3%) which may be attributable to the effect of altitude differences between the two regions. Higher altitudes are characterized by less oxygen partial pressure and hence less metabolic performance.

The birth weight is an important reliable indicator of an infant's health. LBW infants have increased chances of having physical and mental birth defects, contracting diseases and dying early in life [36].

The mean serum zinc for the mothers was 68.57 ± 21.81 µg/dL, which was within the normal range, but close to the lower cut off value, while that of their newborns was 65.05 ± 20.04 µg/dL and below the normal range. These findings were higher than that found by Shommo, 2007 [37]. Similar to our findings, higher maternal zinc levels than their newborns were previously reported [37,38]. However, in other studies maternal zinc levels were found to be lower than their newborns'[39,40].

Moreover, 33.71%of the mothers had serum zinc levels less than normal, whereas serum zinc levels of the newborns were less than normal in 44.05% of them. There was a significant relation (p<0.001) between mothers' and their newborns' serum zinc levels. In agreement with our study, other studies found lower maternal plasma zinc level to be a risk factor for LBW and preterm delivery [39, 40]. Others could not find any correlation [41,42]. The lower newborns' zinc level revealed the inadequacy of zinc transfer at term of pregnancy to the rapidly growing fetus.

CONCLUSIONS

The results showed that34.78% of the mothers were illiterate, and 15.22% informally educated. There was significant correlation between maternal educational state and their newborns' serum zinc levels. The mean of the newborns' weight was 2.8±0.47kg. Moreover,18.45% of them were with LBW. Newborns' birth weight was significantly related to their mothers' serum zinc level. There was a significant relation between mothers' and their newborns' serum zinc levels. Serum zinc was low in about 44% of newborns indicating inadequacy of zinc transfer during pregnancy to the growing fetus.

We recommend improving maternal awareness about antenatal care and supplementation during pregnancy. Promoting appropriate diets and healthy life styles through nutritional education programs and nutritional interventions. Further research on dietary intakes and micronutritional status of Yemeni pregnant women with larger sample sizes including different areas in the country is strongly recommended.

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Table 1: Relationship of maternal educational state and their zinc levels and their newborns' birth weight and zinc levels.

Parameters		Educational state											P-value
		Illiterate		Read & write		1ry Sch		2rySch		Higher		Total		
		N	%	N	%	N	%	N	%	N	%	N	%	
Serum zinc mother	low	9	29.0	6	42.9	9	37.5	4	30.8	2	28.6	30	33.7	0.930
	normal	20	64.5	7	50.0	13	54.2	9	69.2	5	71.4	54	60.7	
	high	2	6.5	1	7.1	2	8.3	0	.0	0	.0	5	5.6	
	total	31	100.0	14	100.0	24	100.0	13	100.0	7	100.0	89	100.0	
Newborn weight	low	5	15.6	3	21.4	5	19.2	1	7.7	3	42.9	17	18.5	0.402
	normal	27	84.4	11	78.6	21	80.8	12	92.3	4	57.1	75	81.5	
	total	32	100.0	14	100.	26	100.	13	100.	7	100.	92	100.	
Serum zinc newborn	low	15	48.4	3	27.3	15	62.5	2	16.7	2	33.3	37	44.0	0.029
	normal	16	51.6	7	63.6	9	37.5	10	83.3	3	50.0	45	53.6	
	high	0	.0	1	9.1	0	.0	0	.0	1	16.7	2	2.4	
	Total	31	100.	11	100.0	24	100.0	12	100.0	6	100.0	84	100.0	

Table 2: Relationship of maternal qat chewing habit and their serum zinc and their newborns' birth weight and zinc levels.

Parameters		Qat chewing								P-value
		Daily		Weekly		None		Total		
		N	%	N	%	N	%	N	%	
Serum zinc mother	low	2	25.0	7	33.3	21	35.0	30	33.7	0.015
	normal	4	50.0	11	52.4	39	65.0	54	60.7	
	high	2	25.0	3	14.3	0	.0	5	5.6	
	Total	8	100.0	21	100.0	60	100.0	89	100.0	
Newborn weight	low	3	37.5	2	9.1	12	19.4	17	18.5	0.198
	normal	5	62.5	20	90.9	50	80.6	75	81.5	
	Total	8	100.0	22	100.0	62	100.0	92	100.0	
Serum zinc newborn	low	2	40.0	13	59.1	22	38.6	37	44.0	0.430
	normal	3	60.0	8	36.4	34	59.6	45	53.6	
	high	0	.0	1	4.5	1	1.8	2	2.4	
	Total	5	100.0	22	100.0	57	100.0	84	100.0	

Table 3: Classification of mothers according to frequency of different foods taken

	Group1) 0		Group2) 1		Group3) 2-3		Group4) >3		Total	
Item/day(d) or week(w)	N	%	N	%	N	%	N	%	N	%
N⁰of full meals/d	0	.00	0	.00	74	80.43	18	19.57	92	100
N⁰ of cups of fluid/d	0	.00	0	.00	21	22.83	71	77.17	92	100
Bread/d	0	.00	6	6.52	79	85.87	7	7.61	92	100
Rice/d	0	.00	91	98.91	1	1.09	0	.00	92	100
Porridge/d	46	50.00	43	46.74	3	3.26	0	.00	92	100
Beans/d	0	.00	42	45.65	49	53.26	1	1.09	92	100
Dairy products/d	5	5.43	59	64.13	28	30.43	0	.00	92	100
Meat/w	9	9.78	75	81.52	8	8.70	0	.00	92	100
Chicken/w	2	2.17	64	69.57	26	28.26	0	.00	92	100
Fish/w	32	34.78	59	64.13	1	1.09	0	.00	92	100
Liver, Kidney/w	57	61.96	35	38.04	0	.00	0	.00	92	100
Eggs/w	8	8.70	15	16.30	69	75.00	0	.00	92	100
No of servings of Vegetables/d	0	.00	89	96.74	3	3.26	0	.00	92	100
No of servings of fruits/w	0	.00	50	54.35	42	45.65	0	.00	92	100
Spicy foods/d	12	13.04	30	32.61	50	54.35	0	.00	92	100
No of cups of tea/d	0	.00	19	20.65	17	18.48	56	60.87	92	100
No of cups of coffee/d	3	3.26	84	91.30	5	5.43	0	.00	92	100

Table 4: Relationship of newborns' birth weight and maternal and newborn's serum zinc levels.

		Newborn Weight (kg)						P-value
		< 2.50		2.50+		Total		
		N	%	N	%	N	%	
Serum zinc mother	**low**	2	6.67	28	93.33	30	100	0.033
	normal	15	27.78	39	72.22	54	100	
	high	0	.00	5	100.00	5	100	
	Total	17	19.10	72	80.90	89	100	
Serum zinc newborn	**low**	6	16.2	31	83.8	37	100	0.29
	normal	10	22.2	35	77.8	45	100	
	high	1	50.0	1	50.0	2	100	
	Total	17	20.2	67	79.8	84	100	

Table 5: Correlation between Serum Zinc Mother and Serum Zinc Newborn

			Serum Zinc Newborn			Total	P-Value
			Low	Normal	High		
Serum Zinc Mother	**Low**	Count	20	6	1	27	< 0.001
		% within Serum Zinc Mother	74.1%	22.2%	3.7%	100.0%	
	Normal	Count	15	37	0	52	
		% within Serum Zinc Mother	28.8%	71.2%	.0%	100.0%	
	High	Count	0	2	1	3	
		% within Serum Zinc Mother	.0%	66.7%	33.3%	100.0%	
Total		Count	35	45	2	82	
		% within Serum Zinc Mother	42.7%	54.9%	2.4%	100.0%	