doi:10.53446/actamednicomedia.1176324

Acta Medica Nicomedia

Cilt: 7 Sayı: 1 Şubat 2024 / Vol: 7 Issue: 1 February 2024
https://dergipark.org.tr/tr/pub/actamednicomedia

Research Article | Araştırma Makalesi

THE EVALUATION OF IODINE LEVELS IN URINE AND NUTRITION IN PREGNANT WOMEN ACCORDING TO TRIMESTER

GEBE KADINLARDA TRİMESTERLERE GÖRE İDRARDA İYOT DÜZEYLERİ VE BESLENME DURUMLARININ DEĞERLENDİRİLMESİ

Rabiye Akin Isik[1]*, Kamile Marakoglu[2]

[1]Department of Obstetrics and Gynecologic Nursing, Faculty of Nursing, Hacettepe University, Ankara, Türkiye. [2]Department of Family Medicine, Faculty of Medicine, Selcuk University, Konya, Türkiye.

ABSTRACT

Objective: Iodine deficiency is a major health problem globally that seriously affects pregnant women and children. The aim of this study was to evaluate urinary iodine levels in pregnant women living in the province of Konya according to trimester.

Methods: A total of 395 pregnant women aged between 15-49, with gestational periods of 1 to 40 weeks were included in the study. A questionnaire prepared by the researchers, with a total of 54 questions, was used to determine the socio-demographic, obstetric, and iodized salt nutritional characteristics of the participants.

Results: The overall median urinary iodine levels were 91.90 µg/L. The mean urinary iodine levels of the pregnant women in the first, second, and third trimesters were 104.00 µg/L in the first trimester, 93.00 µg/L in the second trimester, and 71.00 µg/L in the third trimester. The urinary iodine level was lower in the third trimester and this difference was significant ($p<0.05$). The results revealed that 78.70% of the 395 women had iodine deficiency (<150µg/L). Severe iodine deficiency (0-49µg/L) was detected in 9.90% of pregnant women who were in the first trimester, 15.80% of the women in the second trimester, and in 34.40% of the women in the third trimester.

Conclusion: The pregnant women participating in this study had insufficient iodine levels in their urine, and this deficiency became more prominent as the trimesters continued.

Keywords: Nutrition, pregnancy, trimester, urinary iodine levels

ÖZ

Amaç: İyot eksikliği, tüm dünyada gebe kadınları ve çocukları ciddi şekilde etkileyen önemli bir sağlık sorunudur. Araştırmada, Konya ilinde yaşayan gebelerde trimesterlere göre idrar iyot düzeylerinin değerlendirilmesi amaçlanmıştır.

Yöntem: Araştırmaya, 1-40 hafta arasında gebeliği olan 15-49 yaş aralığındaki 395 gebe kadın dahil edilmiştir. Araştırmacılar tarafından oluşturulan soru formu, katılımcıların sosyo-demografik, obstetric ve iyotlu tuz kullanma özelliklerini içeren beslenmeye yönelik 54 sorudan oluşmaktadır.

Bulgular: Katılımcıların, medyan idrar iyot düzeyleri 91,90 µg/L idi. Gebelerin birinci, ikinci ve üçüncü trimesterdeki medyan idrar iyot düzeyleri sırasıyla 104,00µg/L, 93,00µg/L ve 71,00µg/L idi. Üçüncü trimesterdeki idrar iyot düzeyi anlamlı olarak düşüktü ($p<0,05$). 395 gebe kadının %78,70'inde iyot eksikliği (<150µg/L) olduğu belirlenmiştir. Gebelerin birinci trimesterde %9,90'ında, ikinci trimesterde %15,80'inde ve üçüncü trimesterde %34,40'ında ciddi iyot eksikliği (0-49µg/L) saptandı.

Sonuç: Sonuç olarak, bu çalışmaya katılan gebelerin idrar iyot düzeyi yetersizdi ve bu eksiklik trimester ilerledikçe daha belirgin hale gelmektedir.

Anahtar Kelimeler: Beslenme, gebelik, trimester, idrar iyot düzeyleri

***Corresponding author/İletişim kurulacak yazar:** Rabiye Akin Isik; Department of Obstetrics and Gynecelogic Nursing, Faculty of Nursing, Hacettepe University, Sihhiye Campus, Ankara, 06100, Türkiye.
Phone/Telefon: +90 507 680 42 27 **e-mail/e-posta:** akinrabia35@gmail.com

Submitted/Başvuru: 16.09.2022 • **Accepted/Kabul:** 17.01.2024 • **Published Online/Online Yayın:** 29.02.2024

Introduction

Iodine is a trace element and it is found in the human body in only very small quantities. It is plays a part in synthesizing the thyroid hormones required for normal development and growth.[1,2] Iodine constitutes 65% of thyroxine (T4) and 59% of triiodothyronine (T3), which are thyroid hormones that regulate cell activity and growth in all body tissues.[1] The thyroid gland produces these hormones and they control many metabolic events when passed into the blood, such as the regulation of body temperature and energy, mental development, and normal growth.

As a result of the increase in the production of maternal thyroxine production, there is also a greater need for iodine in the early stages of pregnancy. Iodine is critical for maintaining maternal euthyroidism, and is essential to meeting the requirements for thyroid hormones in the fetus before the start of fetal thyroid tissue functions.[3,4] However, increased iodine loss is observed during pregnancy due to the increase in the maternal glomerular filtration rate (GFR).[5] Therefore, pregnant women should consume sufficient iodine to maintain thyroid hormone production and so that the fetus can develop normally.[6,7] When pregnant women are not able to store sufficient quantities of iodine, this adversely affects maternal and fetal health, as the increasing need due to the pregnancy cannot be met.[8-10] It is known that maternal and fetal hypothyroidism can be caused during pregnancy by even mild to moderate iodine deficiency.[11,12] Severe iodine deficiency in this population can lead to growth retardation, cretinism, fetal brain development pathology, abortions, and perinatal infant death.[8,13,14]

Iodine deficiency is a serious global health problems, and this is particularly the case in pregnant women and children.[15] Worldwide, 700 million people are affected by goiter, with 100 million of these living in Europe. Of the affected European population, 1 million suffer from mental retardation.[16,17] Therefore, the WHO (World Health Organization), UNICEF (United Nations International Children's Emergency Fund), and the ICCIDD (International Iodine Deficiency Disorders Control Council), have recommended that different groups be given iodine supplements as follows: preschool children (0-59 months): 90 µg daily; school-age children (6-12 years): 120 µg daily; adolescents (>12 years old): 150 µg daily; and pregnant and lactating women: 250 µg daily.[18] The WHO has found inadequate iodine intake globally among women who are pregnant, who have an average urinary iodine concentration (UIC) less than 150 µg/L.[18] Therefore, countries without routine salt iodine or supplementation programs should be concerned about how possible endemic iodine deficiency affects women of reproductive age.[18,19]

According to the results of epidemiological studies, Turkey is classified as an area with a mild to moderate iodine deficiency.[20,21] The Turkish Ministry of Health has launched a mandatory program of national salt iodization in order to increase iodine intake across the country. However, research has found that mild to moderate iodine deficiency remains a problem in Turkey.[20-22] Therefore, we aimed in this study to determine UIC values in each of the three trimesters of pregnancy in the province of Konya, which is located in the center of Turkey. In addition, we aimed to investigate the relationship between the socio-demographic and obstetric characteristics of pregnant women and UIC.

Methods

Approval for this prospective study was obtained from the Selcuk University Meram Faculty of Medicine Ethics Committees (2011/054; 24.02.2011). The study was carried out according to the Declaration of Helsinki, and all participants provided their written informed consent. Pregnant women between 15 and 49 years of age, who applied to Konya Faruk Sükan Maternity and Children's Hospital between June 1, 2011 and July 30, 2011 were prospectively included in this study. A total of 395 women, 131 of whom were in the first trimester, 133 of whom were in the second trimester, and 131 of whom were in the third trimester, were included in this study. Excluded were those with a past history of thyroid disease or any other chronic diseases, women who used thyroid drugs, and those who refused to take part.

Questionnaire Information

The questionnaire was designed to gather information about the socio-demographic and obstetric characteristics of the pregnant woman, their use of iodized salt, salt storage conditions, and iodized eating habits. Socio-demographic data collected included the following: age, education level, employment status, profession, age of spouse, working status of spouse, education level, social security status, average family monthly income, and how the decision to get married was made. Obstetric data included whether or not the woman had previously given birth, the type of previous birth (vaginal or cesarean), whether there was a problem during the current pregnancy, history of thyroid disease in the family or herself, and medication used during the current pregnancy. The women were also questioned as to whether the salt they used at home contained iodine, how it was stored, the amount of daily salt consumption, the characteristics of the salt shaker, how often salt was added to food, source of drinking water, and seafood consumption.

Determining Urinary Iodine Levels

Midstream urine was collected in deiodinized plastic tubes, and was then transferred into two 2 ml deiodinized Eppendorf tubes. The urine samples were placed in a deep freezer at -80 C prior to analysis, so that the samples could be analyzed simultaneously. Supernatants were taken following urine sample centrifugation (1500 rpm, three minutes, Hettich Mikro 200R centrifuge). Urine iodine levels (µg/L) were measured via a colorimetric method based on the Sandell-Kolthoff reaction with a ceric arsenic acid solution in the biochemistry laboratory. The lowest level of detection for this method is 20 µg/L. The within run and between run CV values were 6.45% and 9.89%, respectively.

Reference Ranges

Iodine insufficiency was classified according to the level of urinary iodine excreted. According to criteria determined by the WHO, urine iodine levels of less than 150 µg/L are insufficient, those between 150-249 µg/L are sufficient, those between 250 and 499 µg/L demonstrate an intake more than required, and those >500 µg/L are regarded as high, with no expected health benefits. In assessing the insufficiency, 100-149 µg/L were classified as mild iodine insufficiency, 50-99 µg/L as moderate iodine insufficiency, and <50 µg/L as severe iodine insufficiency.

Statistical Analysis

The research data were analyzed with the Statistical Package for Social Sciences (SPSS) 18.0 program. Whether the data were normally distributed was determined via the Kolmogorov-Smirnov test with Lilliefors, a Histogram graph and normal distribution curve, Skewness and Kurtosis. Nonparametric tests were used to analyze non-normally distributed data. Descriptive statistics were presented as numbers, percentages, means, and standard deviations. To understand the relationship between dependent and independent variables, a Mann Whitney U test and a Kruskal-Wallis analysis of variance were carried out. A Chi-square test was used to determine differences between groups, and provided frequency distributions of categorical data. A Pearson Correlation analysis was employed to evaluate the relationship between the socio-demographic characteristics of the participants, obstetric characteristics, and urinary iodine levels. Correlation coefficients (r) were classified as follows: "very weak" between 0.000-0.249, "weak" between 0.250-0.499, "medium" between 0.500-0.699, "high" between 0.700-0.899, and "very high" between 0.900-1.000. A 95.0% confidence interval and a significance level of $p<0.05$ were used for the results.

Results

The socio-demographic characteristics of the 395 pregnant women participating are given in Table 1. Their mean age was 25.65±5.17 years, their mean age at marriage was 20.40±3.39 years, and the mean age of their spouses was 29.73±5.66 years. Of those participating in the study, 93.20% were housewives, 61.00% were primary school graduates (or below), 64.80% lived in nuclear families, and 68.60% perceived their income as "bad". Of the spouses, 53.40% were primary school graduates (or below) and the average number of cigarettes their spouses smoked per day was 16.11±9.11. When the obstetric characteristics of the pregnant women were evaluated, the mean number of pregnancies was 2.53±1.50, 34.40% had not given birth before, 18.70% had previously had a miscarriage, and 50.40% had had a prior normal delivery. When the pregnant women were asked whether they had any problems in their previous pregnancy, 17.70% stated that they had problems (5.80% abortion, 3.30% bleeding, and 1.30% stillbirth). Only 12.40% of the pregnant women stated that their thyroid hormones had been checked, and 17.20% stated that there was a family history of thyroid disease.

Ninety-percent of the pregnant women stated that they consumed iodized salt when at home, 48.90% used 1-2 teaspoons of iodized salt daily, and 74.60% had consumed iodized salt for longer than 5 years. Of the participants, 66.60% reported consuming seafood once a month, 61.30% that they had consumed goitrogenic foods in the three months before their pregnancy, while 30.60% had consumed goitrogenic foods in the first three months of pregnancy.

The relationship between UIC levels according to the socio-demographic characteristics and obstetric characteristics of the participants is shown in Table 2. The median UIC level of the 395 pregnant women in this study was 91.90 µg/L (mean: 104.54±71.68 µg/L). The median UIC level of the 131 women who were in the first trimester was 104.00 µg/L (mean 117.83±76.71 µg/L), the median UIC level of the 133 pregnant women in the second trimester was 93.00 µg/L (mean: 107.59±63.50 µg/L), and the median UIC level of the 131 pregnant women in the third trimester was 71.00 µg/L (mean: 88.13±71.67 µg/L). The UIC levels of the women in the third trimester were significantly less than of the women in the first and second trimesters ($p<0.05$). In addition, the UIC levels of those living in a large family, those who had conceived intentionally, those who were checked for thyroid hormones during pregnancy, those who had used iodized salt for more than five years, and those who consumed goitrogenic foods in the first three months of pregnancy were significantly lower ($p<0.05$). No significant differences were found in terms of the other parameters studied.

The results indicated that 78.70% of the 395 women participating had insufficient UIC levels (<150 µg/L) (Table 3). It was determined that 77.90% of the women in the first trimester, 75.90% of those in the second trimester, and 82.40% of those in the third trimester had insufficient UIC levels (<150 µg/L). UIC level insufficiency between trimesters was not significantly different ($p>0.05$) (Table 4). Severe iodine insufficiency (0-49 µg/L) was detected in 9.90% of the 131 women in the first trimester, in 15.80% of the 133 women in the second trimester, and in 34.40% of the 131 women in the third trimesters. Those in the third trimester had significantly higher severe iodine insufficiency than those in the other trimesters ($p<0.05$).

Table 1. Socio-demographic and obstetric characteristics of pregnant women and their use of iodized salt

Variables	n	%
Gestational age		
1st trimester	131	33.20
2nd trimester	133	33.60
3rd trimester	131	33.20
Age		
17-19	42	10.60
20-24	137	34.70
25-29	120	30.40
30-34	71	18.00
35-41	25	6.30
Education status		
Literate	59	14.90
Primary school	182	46.10
Middle school	93	23.50
High school or equivalent	41	10.40
University and/or post-graduate	20	5.10
Profession		
Housewife	368	93.20
State employee	14	3.50
Private employee or self-employed	13	3.30
Social security		
No	102	25.80
Yes	293	74.20
Civil marriage		
No	24	6.10
Yes	371	93.90
Family type		
Nuclear family	256	64.80
Extended family	139	35.20
Inhabitants of household		
Husband and children	256	64.80
Mother-in-law	24	6.10
Wife's family	106	26.80
Single-person household	9	2.30
Place of longest reside nce		
Rural area	130	32.90
City center	265	67.10
Marriage decision		
Arranged	237	60.00
Love	158	40.00
Perceived income		
Bad	271	68.60
Moderate	118	29.90
Good	6	1.50
Smoking status during pregnancy		
No	336	85.10
Yes	59	14.90
Educational status of husband		
Illiterate	14	3.50
Literate	23	5.80
Primary school	174	44.10
Middle school	91	23.00
High school or equivalent	65	16.50
University and/or post-graduate	28	7.10
Husband's profession		
Unemployed	27	6.80
State employee	27	6.80
Private employee	189	47.80
Self-employed	148	37.50
Retired	4	1.10
Husband's smoking status		
No	175	44.30
Yes	220	55.70
Parity		
No	136	34.40
Yes	259	65.60
Curettage		
No	322	81.50
Yes	73	18.50
Abortion		
No	321	81.30
Yes	74	18.70
Form of delivery		
Normal birth	199	50.40
Cesarean	60	15.20
Number of children		
0	136	34.40
1	130	32.90
2	83	21.10
3 or more	46	11.60
Having problems with a previous pregnancy		
No	325	82.30
Yes	70	17.70
Having problems in current pregnancy		
No	359	90.90
Yes	36	9.10
Planned pregnancy		
No	64	16.20
Yes	331	83.80
Kinship history between spouses		
No	331	83.80
Yes	64	16.20
Evaluation of thyroid hormones during pregnancy		
No	346	87.60
Yes	49	12.40
History of thyroid disease in the husband's family		
No	327	82.80
Yes	68	17.20
Use of iodized salt		
No	37	9.40
Yes	358	90.60
Duration of using iodized salt		
>5 years	91	25.40
<5 years	267	74.60
Daily salt consumption		
1-2 teaspoons	175	48.90
1-2 dessertspoons	108	30.20
1-2 tablespoons	75	20.90
Salt storage container		
Glass jar	283	71.60
Plastic container	79	20.00
Salt bag	33	8.40
Salt-shaker material		
Clear or dark glass	283	71.60
Porcelain	26	6.60
Plastic	86	21.80
Time at which salt added to meals		
Before cooking	179	45.40
Close of cooking	170	43.00
During eating	46	11.60
Type of drinking water used		
Drinking water	166	42.00
Spring water (ready water)	45	11.40
Fresh water (without fountain)	184	46.60
Seafood consumption		
None	103	26.10
2-3 times a week	29	7.30
Once a month	263	66.60
Goitrogenic food consumption 3 months before pregnancy		
Yes	242	61.30
No	153	38.70
Goitrogenic food consumption in the first 3 months of pregnancy		
Yes	274	69.40
No	121	30.60

Table 2. Relationship between UIC levels according to the socio-demographic and obstetric characteristics of the pregnant women

Variables	UIC µg/L	Significance Tests
Gestational age		
1st trimester	104.00	
2nd trimester	93.00	KW:20.106
3rd trimester	**71.00*** **	**p:0.000***
Age		
17-19	84.66	
20-24	89.40	
25-29	97.66	
30-34	89.33	KW:3.482
35-41	79.00	p:0.481***
Education status		
Literate	92.00	
Primary school	88.66	
Middle school	98.00	
High school or equivalent	93.00	KW:2.316
University and/or post-graduate	72.00	p:0.678***
Profession		
Housewife	92.10	
State employee	76.33	KW:1.076
Private employee or self-employed	106.00	p:0.584***
Education status of husband		
Illiterate	95.00	
Literate	91.00	
Primary school	86.50	
Middle school	93.00	
High school or equivalent	99.66	KW:4.502
University and graduate	93.00	p:0.480***
Husband's profession		
Unemployed	106.00	
State employee	82.00	
Private employee	91.00	
Self-employed	92.50	KW:2.898
Retired	68.50	p:0.575***
Family type		
Nuclear family	96.00	z:-2.396
Extended family	86.00	**p:0.017****
Inhabitants of household		
Husband and children	98.00	
Mother-in-law	77.50	
Wife's family	**81.00**	**KW:12.635**
Single-person household	129.00	**p:0.005***
Marriage decision		
Arranged	89.40	KW:0.258
Love	95.66	p:0.879***
Perceived income		
Bad	90.60	
Moderate	96.50	KW:0.741
Good	106.50	p:0.691***
Social security		
No	91.25	z:-0.278
Yes	92.00	p:0.781**
Place of longest residence		
City center	94.33	z:-1.037
Rural area	87.33	p:0.300**
Civil marriage		
No	77.00	z:-1.173
Yes	92.60	p:0.241**
Smoking status during pregnancy		
No	91.10	z:-1.634
Yes	98.66	p:0.102**
Husband's smoking status		
No	97.60	z:-1.358
Yes	88.60	p:0.174**
Parity		
No	91.20	z:-0.404
Yes	93.50	p:0.686**
Curettage		
No	91.45	z:-0.488
Yes	97.00	p:0.625**
Abortion		
No	91.77	z:-0.230
Yes	93.50	p:0.818**
Form of delivery		
Normal birth	96.00	z:-0.892
Cesarean	85.00	p:0.373**
Number of children		
0	91.20	
1	98.60	
2	80.00	KW:2.975
3 or more	97.50	p:0.395***
Having problems with a previous pregnancy		
No		
Yes	91.50	z:-0.826
	94.25	p:0.409**
Planned pregnancy		
No	104.50	z:-2.073
Yes	90.33	**p:0.038*****
Kinship history between spouses		
No	91.54	z:-0.419
Yes	96.00	p:0.675
Evaluation of thyroid hormones during pregnancy		
No	93.33	z:-2.488
Yes	71.00	**p:0.013****
History of thyroid disease in husband's family		
No		
Yes	92.22	z:-0.886
	83.50	p:0.376**
Use of iodized salt		
No	77.00	z:-0.817
Yes	92.36	p:0.414**
Duration of using iodized salt		
>5 years	79.50	z:-2.847
<5 years	97.50	**p:0.04****
Daily salt consumption		
1-2 teaspoons	91.44	
1-2 dessertspoons	95.50	KW:0.340
1-2 tablespoons	90.66	p:0.844***
Salt storage container		
Glass jar	92.62	
Plastic container	77.66	KW:1.519
Salt bag	93.00	p:0.468***
Salt-shaker material		
Clear or dark glass	92.55	
Porcelain	83.00	KW:0.201
Plastic	91.50	p:0.905***
Time salt added to meals		
Before cooking	89.00	
Close of cooking	97.00	KW:1.646
During eating	96.33	p:0.439***
Type of drinking water used		
Drinking water	83.33	
Spring water (ready water)	99.00	KW:4.525
Fresh water (without fountain)	97.00	p:0.104***
Seafood consumption		
None	84.00	
2-3 times a week	86.00	KW:3.222
Once a month	96.50	p:0.200***
Goitrogenic food consumption 3 months before pregnancy		
Yes	86.50	z:-0.770
No	95.40	p:0.441**
Goitrogenic food consumption in the first 3 months of pregnancy		
Yes	87.40	**z:-3.054**
No	104.80	**p:0.002****

* The group that made the difference in the examination with the Bonferroni-corrected Mann-Whitney U test
** Mann-Whitney U test
*** Kruskal-Wallis variance analysis

Table 3. Relationship between the socio-demographic data of the pregnant women and urinary iodine insufficiency

Variables	UIC<150 µg/L (n=311)		UIC>150 µg/L (n=84)		All pregnant (n=395)		p
	n	%	n	%	n	%	
Gestational age							
1st trimester	102	77.90	29	22.10	131	33.20	
2nd trimester	101	75.90	32	24.10	133	33.60	
3rd trimester	108	82.40	23	17.60	131	33.20	0.416*
Age							
17-19	35	83.30	7	16.70	42	10.60	
20-24	111	81.00	26	19.00	137	34.70	
25-29	91	75.80	29	24.20	120	30.40	
30-34	55	77.50	16	22.50	71	18.00	
35-41	19	76.00	6	24.00	25	6.30	0.783*
Profession							
Housewife	288	78.30	80	21.70	368	93.20	
State employee	13	92.90	1	7.10	14	3.50	
Private employee or self-employed	10	76.90	3	23.10	13	3.30	0.418*
Education status							
Literate	46	78.00	13	22.00	59	14.90	
Primary school	148	81.30	34	18.70	182	46.10	
Middle school	69	74.20	24	25.80	93	23.50	
High school or equivalent	32	78.00	9	22.00	41	10.40	
University and/or post-graduate	16	80.00	4	20.00	20	5.10	0.750*
Education status of husband							
Illiterate	11	78.60	3	21.40	14	3.50	
Literate	15	65.20	8	34.80	23	5.80	
Primary school	141	81.00	33	19.00	174	44.10	
Middle school	72	79.10	19	20.90	91	23.00	
High school or equivalent	51	78.50	14	21.50	65	16.50	
University and/or post-graduate	21	75.00	7	25.00	28	7.10	0.653*
Husband 's profession							
Unemployed	18	66.70	9	33.30	27	6.80	
State employee	21	77.80	6	22.20	27	6.80	
Private employee	149	78.80	40	21.20	189	47.80	
Self-employed	119	80.40	29	19.60	148	37.50	
Retired	4	100.00	0	0.00	4	1.00	0.449*
Social security							
No	82	80.40	20	19.60	102	25.80	
Yes	229	78.20	64	21.80	293	74.20	0.635*
Civil marriage							
No	20	83.30	4	16.70	24	6.10	
Yes	291	78.40	80	21.60	371	93.9	0.570*
Parity							
No	106	77.90	30	22.10	136	65.60	
Yes	205	79.20	54	20.80	259	34.40	0.780*
Curettage							
No	258	80.10	64	19.90	322	81.50	
Yes	53	72.60	20	27.40	73	18.50	0.156*
Abortion							
No	252	78.50	69	21.50	321	81.30	
Yes	59	79.70	15	20.30	74	18.70	0.816*
Form of delivery							
Normal birth	157	78.90	42	21.10	199	76.80	
Cesarean	48	80.00	12	20.00	60	23.20	0.853*
Number of children							
0	106	77.90	30	22.10	136	34.40	
1	96	73.80	34	26.20	130	32.90	
2	71	85.50	12	14.50	83	21.00	
3 and more	38	82.60	8	17.40	46	11.60	0.202*
Having problems with a previous pregnancy							
No	254	78.20	71	21.80	325	82.30	
Yes	57	81.40	13	18.60	70	17.70	0.544*
Planned pregnancy							
No	47	73.40	17	26.60	64	16.20	
Yes	264	79.80	67	20.20	331	83.80	0.258*
Kinship history between spouses							
No	258	77.90	73	22.10	331	83.80	
Yes	53	82.80	11	17.20	64	16.20	0.384*

Variables	UIC<150 μg/L (n=311)		UIC>150 μg/L (n=84)		All pregnant (n=395)		p
	n	%	n	%	n	%	
Use of iodized salt							
No	29	78.40	8	21.60	37	9.40	
Yes	282	78.80	76	21.20	358	90.60	0.956*
Duration of using iodized salt							
>5 years	79	86.80	12	13.20	91	25.40	
<5 years	203	76.00	64	24.00	267	74.60	**0.030***
Daily salt consumption							
1-2 teaspoons	138	78.90	37	21.10	175	48.90	
1-2 dessertspoons	83	76.90	25	23.10	108	30.20	
1-2 tablespoons	60	80.00	15	20.00	75	20.90	0.866*
Salt storage container							
Glass jar	221	78.10	62	21.90	283	71.60	
Plastic container	64	81.00	15	19.00	79	20.00	
Salt bag	26	78.80	7	21.20	33	8.40	0.854*
Salt-shaker material							
Clear or dark glass	223	78.80	60	21.20	283	71.60	
Porcelain	20	76.90	6	23.10	26	6.60	
Plastic	68	79.10	18	20.90	86	21.80	0.972*
Time salt added to meals							
Before cooking	133	80.10	33	19.90	166	42.00	
Close of cooking	33	73.30	12	26.70	45	11.40	
During eating	145	78.80	39	21.20	184	46.60	0.614*
Type of drinking water used							
Drinking water	86	83.50	17	16.50	103	26.10	
Spring water (ready water)	21	72.40	8	27.60	29	7.30	
Fresh water (without fountain)	204	77.60	59	22.40	263	66.60	0.317*
Seafood consumption							
None							
2-3 times a week	117	76.50	36	23.50	153	38.70	
Once a month	194	80.20	48	19.80	242	61.30	0.382*
Salt storage container							
Glass jar							
Plastic container	223	81.40	51	18.60	274	69.40	
Salt bag	88	72.70	33	27.30	121	30.60	**0.050***
BMI							
<18.5-24.90	116	80.00	29	20.00	145	37.50	
25-29.90	160	78.00	45	22.00	205	53.00	
30-44.90	32	86.50	5	13.50	37	9.50	0.497*

*Chi-square test

Table 4. Relationship between iodine insufficiency level and trimester

Iodine deficiency level	1st trimester (n=131)		2nd trimester (n=133)		3rd trimester (n=131)		All women (n=395)		χ^2	p
	n	%	n	%	n	%	n	%		
<50 μg/L	13	9.90	21	15.80	**45**	**34.40***	79	20.00	33.664	**0.000***
50-99 μg/L	48	36.60	51	38.30	46	35.10	145	36.70		
100-149 μg/L	41	31.30	29	21.80	17	13.00	87	22.00		
150-249 μg/L	22	16.80	27	20.30	18	13.70	67	17.00		
≥250 μg/L	7	5.40	5	3.80	5	3.80	17	4.30		

*Chi-square test

A weak and negative correlation was determined between UIC and gestational week (r=-0.175, p=0.001). No relationship was found between the UIC level and mother's age (r=-0.035, p=0.577), age at marriage (r=-0.132, p=0.036), duration of marriage (r=-0.030, p=0.632), monthly family income (r=-0.035, p=0.582), number of children (r=-0.021, p=0.738), and children's ages (r=-0.073, p=0.245) (p>0.05) (Table 5).

Table 5. Relationship between some characteristics of the pregnant women and the level of iodine excreted in urine

UIC	Pregnancy week	Age of the pregnant woman	Marriage age	Duration of marriage	Family income	Number of children	Children's ages
R	0.175	-.035	-0.132	-0.030	-.035	-0.021	-0.073
P	-<0.005	>0.577	>0.036	>0.632	>0.582	>0.738	>0.245

Discussion

As a result of an increase in renal iodine clearance, an increase in production of thyroid hormone, and the iodine transplacental passage to the fetus, pregnant women require more iodine than they did prior to conceiving, and are therefore susceptible to iodine deficiency.[23] Women who are pregnant require 250 µg or more iodine/day, which is more than that required for women of reproductive age who are not carrying a child.[18] Pregnant women meet most of this iodine requirement through the foods they eat. More than 90% of the necessary iodine in the human body is consumed in foods, and most of the iodine in the diet is excreted by the kidneys.[24] Therefore, UIC serves as a useful way of measuring iodine intake.[25,26] A median UIC of 150-249 µg/L during pregnancy indicates that the quantity of iodine being taken in is adequate.[18] Iodine deficiency and its related problems continue to be a major health problem for children and pregnant women worldwide. As much as 31% of the global population, especially in South Asia and Europe, is thought to be affected by iodine deficiency.[16-18] Even women living in countries where iodine is sufficient often suffer from iodine deficiency during pregnancy as a result of their increased need for iodine when pregnant.[19,27,28] Mandatory and voluntary programs to supplement food with iodine have been initiated in various locations worldwide in order to prevent the disorders caused by iodine deficiency. Fortifying salt with iodine was made mandatory in Turkey in 1998. The 2008 Turkey Demographic and Health Survey (TDHS) reported that Turkey has an iodized salt consumption rate of 85.3% overall, with 89.9% in city centers and 71.5% in other areas.[29] The results of the current study, indicating that 90.6% of participants used iodized salt, are similar to the results of TDHS 2008. However, other studies have shown that the rate of consumption of iodized salt at home was only 56.5%.[30] Anaforoglu et al.[31] reported that only a quarter of patients were using containers suitable for iodized salt. Despite the mandatory use of iodized salt, iodine deficiency can also be caused by storing or consuming iodized salt in an improper way.

Prior to the iodized salt requirement, the average UIC level in Turkey was 25.5 mg/L.[32] After iodine supplementation was made obligatory, the average UIC level saw and increase to 87 µg/L in 2002, 117 µg/L in 2004, and 130 µg/L in 2009.[30] Despite this improvement, iodine deficiency remains a major problem. Pregnant women's UIC levels in a number of cities in various regions of Turkey have been reported to be 149.7 µg/L[33], 80.5 µg/L[34], and 77.4 µg/L.[22] Oğuz Kutlu and Kara[34] reported that 72.8% of women in their second trimester had iodine deficiency in Turkey. In their study, Koyuncu et al.[35] determined the median UIC value of 440 pregnant women in the first trimester as 81.6 µg/L (1-414 µg/L). In that study, UIC was less than 150 µg/L in 373 (86.7%) of the women, 9 (2.04%) women had a UIC above 250 µg/L, and only 58 women (13.24%) had a sufficient intake of iodine. The current study found that the median UIC of the 395 pregnant women was 91.90 µg/L (104.54±71.68 µg/L). These findings are similar to those of prior studies, and despite the mandatory consumption of iodized salt, iodine deficiency clearly remains an issue in our region. The current study found that the median urinary iodine level of the 131 women in the first trimester was 104.00 µg/L (117.83±76.71 µg/L), the median urinary iodine level of the 133 women in the second trimester was 93.00 µg/L (107.59±63.50 µg/L), while the median urinary iodine level of the 131 women in the third trimester was 71.00 µg/L (88.13±71.67 µg/L). The iodine levels of the women in the third trimester were significantly lower than those of the women in the first and second trimesters.

Azizi et al.[36] also determined that the UIC value at the third trimester was lower than at the first and second trimesters. The median UIC decreased from being sufficient in the first trimester to being insufficient in the third trimester.[37] Similarly, Amouzegar et al.[38] determined that the UIC value of pregnant women was 218 mg/L in the first trimester, 160 mg/L in the second trimester, and 145 mg/L in the third trimester. In the current study, the decreased UIC values in the third trimester were consistent with the abovementioned studies, and reflect how the need for iodine increases as the pregnancy progresses.

In the current study, it was found that 78.70% of the 395 pregnant women participating had insufficient urinary iodine levels (<150 µg/L). Of the women, 77.90% of those in the first trimester, 75.90% of those in the second trimester, and 82.40% of those in the third trimester had insufficient urinary iodine levels (<150 µg/L). It is of the utmost importance to note that the rate of severe iodine insufficiency in the pregnant women in the third trimester was approximately three times greater than the rates of the women in the first and second trimesters. This result indicates that as the pregnancy progresses, the need for iodine increases, and that this need was not being met. No significant difference was found in terms of the use of iodized salt in pregnant women, the amount consumed daily, the location of salt storage, type of salt dispenser, when salt was used in meals, the source of drinking water, seafood consumption, and urinary iodine level ($p>0.05$). These findings demonstrate a Mouzadar consistency with those of previous studies.[22,33,39,40] However, it was observed that those living in extended families and those who consumed goitrogenic foods in the first three months of pregnancy had lower UIC values. Salt consumption tends to decrease in extended families due to elderly family members and the chronic diseases they may have. It was observed that the UIC values were higher in those who had intended to conceive, in those who were checked for thyroid hormones during pregnancy, and in those who had used iodized salt for more than five years.

In conclusion, the results of the current study indicate that the average UIC value of pregnant women in Konya indicates iodine insufficiency, and the average UIC decreased even further in the third trimester. In order to combat this iodine deficiency and achieve the levels recommended, the general population should be monitored on a regular basis, and the use of iodine supplements should be promoted, especially to pregnant women.

Compliance with Ethical Standards

This study was approved Selcuk University Meram Faculty of Medicine Ethics Committees (Decision number: 2011/054, Date: 24.02.2011).

Conflict of Interest

The authors have no conflicts of interest relevant to this article.

Author Contribution

The authors contributed equally to this work.

Financial Disclosure

The authors declare that this study has received no financial support.

References

1. Andersson M, Takkouche B, Egli I, Allen HE, de Benoist B. Current global iodine status and progress over the last decade towards the elimination of iodine deficiency. *Bull World Health Organ.* 2005;83:518-525.
2. Wang Y, Zhang Z, Ge P, Wang Y, Wang S. Iodine deficiency disorders after a decade of universal salt iodization in a severe iodine deficiency region in China. *Indian J Med Res.* 2009;130:413-417.
3. Glinoer D. Maternal and fetal impact of chronic iodine deficiency. *Clin Obstet Gynecol.* 1997;40:102-116.
4. Glinoer D. Iodine nutrition requirements during pregnancy. *Thyroid.* 2006;16:947-948. doi:10.1089/thy.2006.16.947
5. Dafnis E, Sabatini S. The effect of pregnancy on renal function: physiology and pathophysiology. *Am J Med Sci.* 1992;303:184-205. doi:10.1097/00000441-199203000-00011
6. Glinoer D. The regulation of thyroid function during normal pregnancy: importance of the iodine nutrition status. *Best Pract Res Clin Endocrinol Metab.* 2004;18:133-152. doi:10.1016/j.beem.2004.03.001
7. Perez-Lopez FR. Iodine and thyroid hormones during pregnancy and postpartum. *Gynecol Endocrinol.* 2007;23:414-428. doi:10.1080/09513590701464092
8. Dunn JT, Delange F. Damaged reproduction: the most important consequence of iodine deficiency. *J Clin Endocrinol Metab.* 2001;86:2360-2363. doi:10.1210/jcem.86.6.7611
9. Elnagar B, Eltom A, Wide L, Gebre-Medhin M, Karlsson FA. Iodine status, thyroid function and pregnancy: study of Swedish and Sudanese women. *Eur J Clin Nutr.* 1998;52:351-355. doi:10.1038/sj.ejcn.1600563
10. Hershman JM. Physiological and pathological aspects of the effect of human chorionic gonadotropin on the thyroid. *Best Pract Res Clin Endocrinol Metab.* 2004;18:249-265. doi:10.1016/j.beem.2004.03.010
11. Zimmermann MB. Iodine deficiency. *Endocr Rev.* 2009;30:376-408. doi:10.1210/er.2009-0011
12. Zimmermann MB, Jooste PL, Pandav CS. Iodine-deficiency disorders. *Lancet.* 2008;372:1251-1262. doi:10.1016/S0140-6736(08)61005-3
13. Pearce EN, Hollowell JG, Jr. Iodine nutrition--more is better. *N Engl J Med.* 2006; 355:1500; author reply 1501.
14. Zimmermann MB. The effects of iodine deficiency in pregnancy and infancy. *Paediatr Perinat Epidemiol.* 2012; 26(suppl1):108-117. doi:10.1111/j.1365-3016.2012.01275.x
15. World Health Organization. Iodine Status Worldwide:WHO Global Database on Iodine Deficiency. Geneva: WHO; 2004. http://apps.who.int/iris/bitstream/10665/43010/1/9241592001.pdf. Accessed April 07.
16. Scientific Committee on Food. Opinion of the Scientific Committee on Food on the Tolarable Upper Intake Level of Iodine. Belgium: SCF; 2002. http://ec.europa.eu/food/fs/sc/scf/out146_en.pdf.
17. World Health Organization/UNICEF/International Council for Control of Iodine Deficiency Disorders.Assessment of Iodine Deficiency Disorders and Monitoring Their Elimination, a Guide for Programme Managers (2nd ed). Geneva: WHO; 2001. http://www.who.int/nutrition/publications/en/idd_assessment_monitoring_eliminination.pdf.
18. World Health Organization/UNICEF/International Council for Control of Iodine Deficiency DisordersAssessment of Iodine Deficiency Disorders and Monitoring Their Elimination: A Guide for Programme Managers, 3rd edn. Geneva: WHO; 2007. http://apps.who.int/iris/bitstream/10665/43781/1/9789241595827_eng.pdf.
19. Zimmermann MB, Gizak M, Abbott K, Andersson M, Lazarus JH. Iodine deficiency in pregnant women in Europe. *Lancet Diabetes Endocrinol.* 2015;3:672-674. doi:10.1016/S2213-8587(15)00263-6
20. Erdogan G, Erdogan MF, Delange F, Sav H, Gullu S, Kamel N. Moderate to severe iodine deficiency in three endemic goitre areas from the Black Sea region and the capital of Turkey. *Eur J Epidemiol.* 2000;16:1131-1134. doi:10.1023/A:1010959928862
21. Yordam N, Ozon A, Alikasifoglu A, et al. Iodine deficiency in Turkey. *Eur J Pediatr.* 1999;158:501-505. doi:10.1007/s004310051130
22. Egri M, Ercan C, Karaoglu L. Iodine deficiency in pregnant women in eastern Turkey (Malatya Province): 7 years after the introduction of mandatory table salt iodization. *Public Health Nutr.* 2009;12:849-852. doi:10.1017/S1368980008003315
23. Glinoer D. Pregnancy and iodine. *Thyroid.* 2001;11:471-481.
24. Nicola JP, Basquin C, Portulano C, Reyna-Neyra A, Paroder M, Carrasco N. The Na+/I- symporter mediates active iodide uptake in the intestine. *Am J Physiol Cell Physiol.* 2009;296:C654-662. doi:10.1152/ajpcell.00509.2008
25. Mitka M. Even mild iodine deficiency during gestation may impair brain function in children. *JAMA.* 2013;309:2428. doi:10.1001/jama.2013.7239
26. Wei Z, Wang W, Zhang J, Zhang X, Jin L, Yu X. Urinary iodine level and its determinants in pregnant women of Shanghai, China. *Br J Nutr.* 2015;113:1427-1432. doi:10.1017/S0007114515000665
27. Caldwell KL, Pan Y, Mortensen ME, Makhmudov A, Merrill L, Moye J. Iodine status in pregnant women in the National Children's Study and in U.S. women (15-44 years), National Health and Nutrition Examination Survey 2005-2010. *Thyroid.* 2013;23:927-937. doi:10.1089/thy.2013.0012
28. Gowachirapant S, Winichagoon P, Wyss L, et al. Urinary iodine concentrations indicate iodine deficiency in

pregnant Thai women but iodine sufficiency in their school-aged children. *J Nutr.* 2009;139:1169-1172. doi:10.3945/jn.108.100438

29. HUIPS. *Turkey Demographic and Health Survey, THDS 2008. Hacettepe University Institute of Population Studies, Ministry of Health General Directorate of Mother and Child Health and Family Planning, T.R. Prime Ministry Undersecretary of State Planning Organization and TÜBİTAK*. Ankara, TURKEY, 2008.
30. Erdogan MF, Agbaht K, Altunsu T, et al. Current iodine status in Turkey. *J Endocrinol Invest.* 2009;32:617-622. doi:10.1007/BF03346519
31. Anaforoglu I, Algun E, Incecayir O, Topbas M, Erdogan MF. Iodine status among pregnant women after mandatory salt iodisation. *Br J Nutr.* 2016;115:405-410. doi:10.1017/S0007114515004559
32. Erdogan G, Erdogan MF, Emral R, et al. Iodine status and goiter prevalence in Turkey before mandatory iodization. *J Endocrinol Invest.* 2002;25:224-228. doi:10.1007/BF03343994
33. Kut A, Gursoy A, Senbayram S, Bayraktar N, Budakoglu, II, Akgun HS. Iodine intake is still inadequate among pregnant women eight years after mandatory iodination of salt in Turkey. *J Endocrinol Invest.* 2010;33:461-464. doi:10.1007/BF03346625
34. Oguz Kutlu A, Kara C. Iodine deficiency in pregnant women in the apparently iodine-sufficient capital city of Turkey. *Clin Endocrinol (Oxf).* 2012;77:615-620. doi:10.1111/j.1365-2265.2012.04440.x
35. Koyuncu K, Turgay B, Soylemez F. Iodine deficiency in pregnant women at first trimester in Ankara. *J Turk Ger Gynecol Assoc.* 2019;20:37-40. doi:10.4274/jtgga.galenos.2018.2017.0150
36. Azizi F, Aminorroya A, Hedayati M, Rezvanian H, Amini M, Mirmiran P. Urinary iodine excretion in pregnant women residing in areas with adequate iodine intake. *Public Health Nutr.* 2003;6:95-98. doi:10.1079/PHN2002366
37. Ainy E, Ordookhani A, Hedayati M, Azizi F. Assessment of intertrimester and seasonal variations of urinary iodine concentration during pregnancy in an iodine-replete area. *Clin Endocrinol (Oxf).* 2007;67:577-581. doi:10.1111/j.1365-2265.2007.02928.x
38. Amouzegar A, Khazan M, Hedayati M, Azizi F. An assessment of the iodine status and the correlation between iodine nutrition and thyroid function during pregnancy in an iodine sufficient area. *Eur J Clin Nutr.* 2014;68:397-400. doi:10.1038/ejcn.2013.273
39. Alvarez-Pedrerol M, Ribas-Fito N, Garcia-Esteban R, et al. Iodine sources and iodine levels in pregnant women from an area without known iodine deficiency. *Clin Endocrinol (Oxf).* 2010;72:81-86. doi:10.1111/j.1365-2265.2009.03588.x
40. Andersson M, de Benoist B, Rogers L. Epidemiology of iodine deficiency: Salt iodisation and iodine status. *Best Pract Res Clin Endocrinol Metab.* 2010;24:1-11. doi:10.1016/j.beem.2009.08.005