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RESEARCH ARTICLE

Assessment of iodine status in adults: A case study of Amasya

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KEYWORDS

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Assessment of Iodine Status in Adults: A Case Study of Amasya

ABSTRACT

Introduction: The prevalence of iodine deficiency in Turkey significantly decreased after iodine fortification of table salt, but regional differences may still exist. The objective of this cross-sectional study was to assess the iodine levels among adults residing in Amasya.

Methodology: This study, which included 232 adults aged 18-64 years, was conducted in a public hospital in Amasya. The study data were obtained through a questionnaire form applied to individuals through face-to-face interviews. After taking general information and anthropometric measurements of the individuals participating in the study, urinary iodine levels were analyzed.

Results: The mean urinary iodine level was 13.7 (1.5) µg/dL. Iodine status of 99.6% of the participants is normal and 64.9% of them use iodized salt. Alcohol consumption and body mass index showed a statistically significant difference according to urinary iodine level classification (median value). In individuals who consume iodized salt, the frequency of those with urinary iodine levels above the median value is higher compared to those who do not consume iodized salt.

Conclusions: This study shows the iodine status of adult individuals living in Amasya. In future studies, dietary iodine intake of individuals should also be evaluated, and iodine status should be examined in vulnerable groups such as pregnant, lactating and elderly.

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PALABRAS CLAVE

Yodo;

Deficiencia de Yodo;

Cloruro de Sodio Dietético.

Valoración del estado de yodo en adultos: Un estudio de caso de Amasya

RESUMEN

Introducción: La prevalencia de la deficiencia de yodo en Turquía disminuyó significativamente después de la fortificación de la sal de mesa con yodo, pero podrían existir diferencias regionales. El objetivo de este estudio transversal fue evaluar los niveles de yodo entre los adultos residentes en Amasya.

Metodología: Este estudio, que incluyó a 232 adultos de entre 18 y 64 años, se realizó en un hospital público en Amasya. Los datos del estudio se obtuvieron a través de un cuestionario aplicado a los individuos mediante entrevistas cara a cara. Después de recoger la información general y las medidas antropométricas de los individuos que participaron en el estudio, se analizaron los niveles de yodo en la orina.

Resultados: El nivel medio de yodo en orina fue de 13,7 (1,5) µg/dL. El nivel de yodo del 99,6% de los participantes fue normal y el 64,9% de ellos utilizaba sal yodada. El consumo de alcohol y el índice de masa corporal mostraron una diferencia estadísticamente significativa según la clasificación del nivel de yodo en orina (valor mediano). En individuos que consumieron sal yodada, la frecuencia de aquellos con niveles de yodo en orina por encima del valor mediano fue mayor en comparación con aquellos que no la consumieron.

Conclusiones: Este estudio muestra el estado de yodo de los adultos que viven en Amasya. En futuros estudios, también se debe evaluar la ingesta dietética de yodo de los individuos y examinar el estado de yodo en grupos vulnerables como embarazadas, lactantes y ancianos.

KEY MESSAGES

1. Nearly all participants exhibited normal urinary iodine levels, indicating successful iodine fortification in Amasya.

2. The majority of individuals, approximately 65%, consumed iodized salt, ensuring sufficient iodine intake.

3. Significant differences in alcohol consumption and BMI classification were observed based on urinary iodine levels.

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INTRODUCTION

Iodine is a trace element found in small amounts (15-20 mg) in the human body, necessary for normal growth and development. Sixty-five percent of thyroxine (T4) and fifty-nine percent of triiodothyronine (T3) are comprised of iodine[1]. These hormones produced by the thyroid gland play roles in various metabolic processes in the body such as growth, reproduction, neuronal development, and energy metabolism[2,3].

Fish, seafood, dairy, veggies, and fruits are some iodine-rich foods[4]. However, fish intake isn't typically sufficient in many nations to meet daily iodine needs. The iodine levels in veggies and fruits depend on soil type, which varies globally[5]. Milk and dairy products contain iodine concentrations ranging from 200-1000 µg/L, influenced by factors like animal feed iodine content, farming methods, disinfectant use, goitrogen presence in feed, and seasonal changes[4,6]. Therefore, iodized salt is the primary source of iodine in most countries[6].

Adults are advised to consume 150 µg of iodine daily through diet[7]. When the daily iodine intake through diet is less than 150 µg/day, the risk of iodine deficiency increases[8]. Iodine deficiency remains a significant public health issue globally, leading to cognitive impairment and developmental delays in children, which can result in higher neonatal mortality rates[9]. Women of reproductive age and school-age children are considered to be particularly vulnerable to iodine deficiency. Furthermore, mild-to-moderate iodine deficiency-related thyroid dysfunction is associated with an increased prevalence of chronic diseases among adults and the elderly[10,11]. As a result, the World Health Organization advises routine monitoring of iodine levels across all demographics.

Universal Salt Iodization strategy and iodine supplementation programs are being implemented worldwide to reduce the prevalence of iodine deficiency[12]. In this context, it is estimated that in 2016, three-quarters of the world's population used iodized salt in 130 countries[13]. Over the last two decades, there has been a decrease in the number of countries facing iodine deficiency from 54 to 30, while the number of countries with sufficient iodine levels has risen from 67 to 11[14]. In Turkey, for instance, the prevalence of moderate to severe iodine deficiency was 58.0% in 1997. Following the introduction of mandatory iodization of table salt in 1998, the prevalence of iodine deficiency was found to be 28.2% in 2008. A study conducted across 30 provinces revealed that iodine levels were sufficient in 20 provinces[15]. Nevertheless, in recent years, certain developing and developed nations have experienced either iodine deficiency (such as Cambodia, Russia, Israel) or excessive iodine consumption (like South Korea, Cameroon, Colombia), both of which can negatively impact health[16,17].

In recent years, there have been reports of changes in the effectiveness of iodine prophylaxis due to various factors. These include the processing of foods using iodine-free salt, the increased use of alternative salts like rock salt or sea salt as substitutes for table salt, which has been driven by media or endorsements from celebrities, and the restriction of salt intake to reduce high blood pressure[12]. Thus, it's crucial to track iodine levels in order to assess the efficacy and consequences of iodized salt consumption in people. Despite a notable reduction in iodine deficiency nationwide following the implementation of salt iodization in Turkey, there may still be regional differences. The aim of this study was to assess iodine levels in adults residing in Amasya.

METHODOLOGY

Study design and subjects

The sample of this cross-sectional study consisted of individuals aged between 18 and 64 who presented to the Department of Internal Medicine Outpatient Clinic at Amasya University Training and Research Hospital for examination and follow-up. It was determined that 900 adult individuals applied to the Department of Internal Medicine Outpatient Clinic at Amasya University Training and Research Hospital for three months. The sample size of the study was calculated using the known population sampling formula (n=N.t2.p.q/d2.(N-1)+1t2.p.q). Accordingly, the sample size was determined based on an acceptable error amount of 5% and a confidence level of 95% (t=1.96) (sampling error of d=0.05). The general rule for this type of sampling is (p)=(q)=0.5. In this case, the largest possible sample volume is obtained with a constant sampling error. According to the results, it was aimed to reach 208 individuals within the scope of the study.

Participants aged 20-64, not pregnant or lactating, without a history of thyroid disease, and not using medications for thyroid treatment were included. Although 250 individuals were reached for the study, some were excluded for various reasons (those who did not provide voluntary consent, those with a history of thyroid disease, pregnant or lactating individuals, those following a special diet). Consequently, the study sample comprised 232 individuals who met the inclusion criteria.

Informed written consent was obtained from all participants prior to data collection. Ethics Committee Permission was obtained from Amasya University for this study (No. 050.04-175129). All study procedures were conducted according to the guidelines of the Declaration of Helsinki[18].

Data Collection

Participant Demographics: In the demographic section, participants were asked to provide information regarding their sex, age, educational status, smoking and alcohol consumption status, place of residence (urban/rural), presence of chronic diseases, and medication use. To determine the type of salt used by the participants, the question "Which type of salt do you use in your daily diet?" was posed.

Anthropometric Measurements: Anthropometric measurements included measurements of individuals' body weight and height. Participants' body weight measurements were taken in the morning on an empty stomach, wearing light clothing and without shoes, using a calibrated Tanita (MC-780) scale. The height of the participants was measured with an unstrained measuring tape against the wall, with the head, hips, and heels touching the wall and the eyes and earlobes at the same level (in the Frankfort plane).

Body mass index (BMI) was determined by dividing body weight in kilograms by the square of height in meters. According to WHO standards, individuals were categorized as follows: BMI <18.50 kg/m^2 classified as "underweight," BMI between 18.50 and 24.99 kg/m^2 categorized as "normal weight," BMI between 25.0 and 29.99 kg/m^2 labeled as "overweight," and BMI ≥30.00 kg/m^2 identified as "obese"[19].

Assessment of Urinary Iodine Excretion: The information of individuals who visited the Department of Internal Medicine Outpatient Clinic at Amasya University Training and Research Hospital for examination and follow-up, and had their first morning urine samples tested for iodine excretion, was obtained from the hospital system. The classification of participants' iodine levels was based on urinary iodine excretion levels. The results were evaluated according to the criteria set by the hospital, which defined a urinary iodine level of <10 µg/dL as indicative of insufficient iodine intake, while a level of 10-20 µg/dL was deemed to indicate sufficient iodine intake.

Statistical Analyses

Variable normality was assessed using analytical techniques (Kolmogorov-Smirnov/Shapiro-Wilk tests). Descriptive statistics were presented using means and standard deviations for normally distributed variables. The Mann-Whitney U test was applied for comparing variables between independent groups with non-normally distributed data, while the independent samples T-test was utilized for normally distributed data. In cases where the data were parametric, the Pearson Chi-square test was employed for the comparison of categorical variables (such as sex, demographic information) between groups. In contrast, the Fisher's exact Chi-square test was used for non-parametric cases. All analyses were evaluated at 0.05 significance level and statistically significant results are indicated with p-values in bold.

RESULTS

General information of the participants is given in Table 1. Of the 232 adult individuals participating in the study, 59.9% were female, with a mean age of 37.9 years. Significant differences were observed in age classification, educational status, smoking and alcohol consumption status, and BMI classification by sex ($p<0.05$). Fifty percent of females were in the 18-35 age group, with 18% having primary or middle school education ($p<0.05$). Among males, the frequency of smokers and alcohol consumers, as well as overweight and obese individuals, was found to be higher ($p<0.05$). It was determined that 99.6% of the individuals participating in the study had normal urinary iodine levels, and 64.9% used iodized salt.

Characteristic information of the participants according to urinary iodine level classification is shown in Table 2. Since nearly all the individuals participating in the study had normal urinary iodine levels, analyses were conducted by classifying iodine levels based on the median value. It was determined that there was a significant difference in the frequency of alcohol consumption and the classification of BMI according to urinary iodine levels ($p<0.05$). Among individuals with a urinary iodine level of ≤13.5 µg/dL, the frequency of alcohol consumption and the prevalence of obesity were higher ($p<0.05$).

Figure 1 shows urinary iodine levels according to iodized salt usage. It was determined that there is a statistically significant difference in iodine levels based on iodized salt usage. The frequency of individuals with urinary iodine levels >13.5 µg/dL was found to be higher among those who use iodized salt ($p<0.05$).

DISCUSSION

This study was conducted to assess the iodine status among individuals aged 18-64 residing in Amasya. The mean urinary iodine level of the participants was found to be 13.7 (1.5). It was determined that 99.6% of the participants had normal iodine status, and 64.9% used iodized salt. When urinary iodine levels were classified according to the median value (13.5 µg/dL), significant differences were observed in alcohol consumption

Table 1. Characteristic information of participants according to sex.

	Female (n=139)	Male (n=93)	Total (n=232)	p
Age (years)	36.8 (12.9)	39.7 (12.1)	37.9 (12.7)	0.088
18-35	70 (50.4)	31 (33.3)	101 (43.5)	**0.023**
36-50	47 (33.8)	47 (50.5)	94 (40.5)	
≥50	22 (15.8)	15 (16.1)	37 (15.9)	
Education level				
Primary and secondary school	25 (18.0)	3 (3.2)	28 (12.1)	**0.002**
High school	61 (43.9)	42 (45.2)	103 (44.4)	
University	53 (38.1)	48 (51.6)	101 (43.5)	
Residency				
Rural	18 (12.9)	8 (8.6)	26 (11.2)	0.304
Urban	121 (87.1)	85 (91.4)	226 (88.8)	
Smoking				
Yes	26 (18.7)	35 (37.6)	61 (26.3)	**0.001**
No	113 (81.3)	58 (62.4)	171 (73.7)	
Alcohol consumption				
Yes	24 (17.3)	36 (38.7)	60 (25.9)	**<0.001**
No	115 (82.7)	57 (61.3)	172 (74.1)	
BMI classification				
Underweight	7 (5.0)	3 (3.2)	10 (4.3)	**0.012**
Normal	51 (36.7)	18 (19.4)	69 (29.7)	
Overweight	43 (30.9)	45 (48.4)	88 (37.9)	
Obese	38 (27.3)	27 (29.0)	65 (28.0)	
Chronic disease				
Yes	15 (10.8)	12 (12.9)	27 (11.6)	0.623
No	124 (89.2)	81 (87.1)	205 (88.4)	
Urinary iodine status	13.6 (1.6)	13.9 (1.5)	13.7 (1.5)	0.147
<10 µg/dL	0 (0.0)	1 (1.1)	1 (0.4)	0.401
10-20 µg/dL	139 (100.0)	92 (98.9)	231 (99.6)	
Iodized salt use	86 (62.3)	64 (68.8)	150 (64.9)	0.310

BMI: Body mass index; **SD:** Standard deviation.

The means (standard deviations) were given for normally distributed data, and the median and min-max for non-normally distributed data. Categorical variables are expressed as n (%).

frequency and BMI classification. Among those who consumed iodized salt, the proportion of individuals with urinary iodine levels above 13.5 µg/dL was higher.

To determine individuals' iodine intake through diet, food consumption records or food consumption frequencies can be used. However, due to regional variations in the iodine content of

Table 2. Characteristic information of participants according to urinary iodine level classification.

	≤ 13.5 μg/dL (n=119)	> 13.5 μg/dL (n=113)	p
Age (years)	37.9 (12.8)	38.0 (12.6)	0.969
18-35	53 (44.5)	48 (42.5)	0.625
36-50	45 (37.8)	49 (43.4)	
≥50	21 (17.6)	16 (14.2)	
Education level			
Primary and secondary school	20 (16.8)	8 (7.1)	0.064
High school	52 (43.7)	51 (45.1)	
University	47 (39.5)	54 (47.8)	
Residency			
Rural	14 (11.8)	12 (10.6)	0.782
Urban	105 (88.2)	101 (89.4)	
Smoking			
Yes	91 (76.5)	80 (70.8)	0.326
No	28 (23.5)	33 (29.2)	
Alcohol consumption			
Yes	95 (79.8)	77 (68.1)	**0.042**
No	24 (20.2)	36 (31.9)	
BMI classification			
Underweight	4 (3.4)	6 (5.3)	**0.028**
Normal	37 (31.1)	32 (28.3)	
Overweight	36 (30.3)	52 (46.0)	
Obese	42 (35.3)	23 (20.4)	

BMI: Body mass index; **SD:** Standard deviation.

The means (standard deviations) were given for normally distributed data, and the median and min-max for non-normally distributed data. Categorical variables are expressed as n (%).

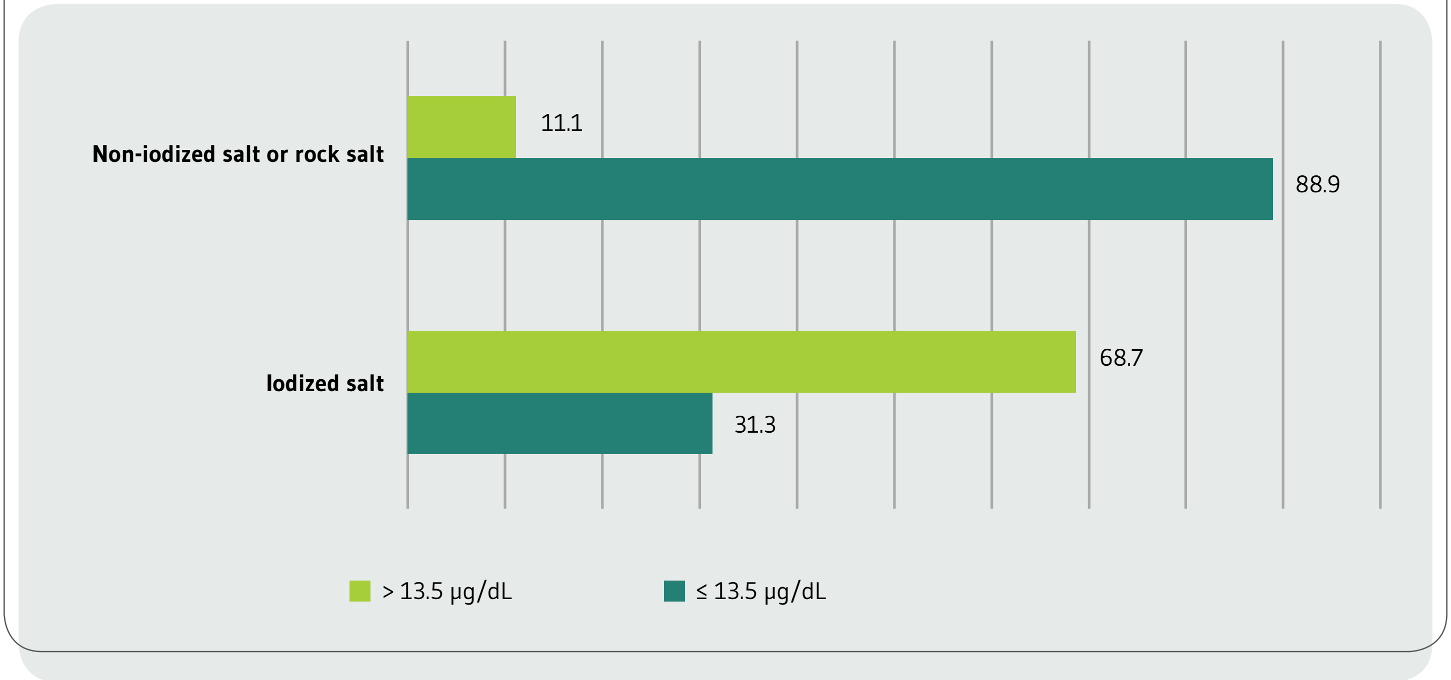
foods, these methods may not provide accurate assessments of iodine intake[20]. Given that over 90% of iodine intake is excreted in urine, urinary iodine level represent the most reliable indicator of recent iodine intake. While the collection of 24-hour urine samples is the preferred method for estimating iodine intake, it is impractical in epidemiological studies. Therefore, spot urine samples are collected and presented as a median[1].

In this study, individuals' urinary iodine level was analyzed by collecting spot urine samples. The mean urinary iodine level of the participants was found to be 13.7 (1.5) μg/dL, and 99.6% of them were determined to have normal iodine status. In a study conducted in Ankara in 2017 with individuals aged 18-64, iodine deficiency was found in 91.8% of individuals with diabetes and 55.1% of individuals in the control group, according to urinary iodine level classification[21]. In another study conducted by Ozpinar *et al.*[22] in three cities, the average urinary iodine level in non-pregnant and non-lactating women was found to be 77.5 μg/L in Istanbul, 58.8 μg/L in Isparta, and 69.8 μg/L in Kayseri. In contrast to previous studies conducted in Turkey, this study found that almost all participants had normal iodine intake. Variations in study outcomes could stem from disparities in sample demographics and soil iodine levels, which may vary across different urban areas. Nevertheless, the results indicate that the iodine prophylaxis implemented as a public health strategy in Turkey is effective.

Various factors such as sex, age, socio-cultural factors, geographic location, and season can influence urinary iodine level. In this study, a higher frequency of individuals who consume alcohol and are obese was observed in the group with urinary iodine levels ≤13.5 μg/dL. In a study conducted by Rasmussen *et al.*[23], it was found that participants with a high frequency of alcohol consumption had higher urinary iodine level. The diuretic effect of alcohol can lead to fluid loss and increase urinary iodine level. Furthermore, individuals who consume alcohol may experience nutritional deficiencies, which can affect the amount of iodine level in urine. It is notable that obesity represents as a significant risk factor for iodine deficiency. Soriguer *et al.*[24] reported that urinary iodine levels were lower in obese individuals compared to those with normal body weight. The physiological pathways linking obesity and iodine status have not yet been fully elucidated. However, it is reported that obese individuals may consume less iodine through their diet or may have impaired iodine absorption due to consuming more fat along with their diet[25]. The increase in the prevalence of obesity may pose a risk for iodine deficiency. However, further research is needed to investigate this relationship.

Salt iodization is a public health approach designed to alleviate iodine deficiency. In Turkey salt iodization became mandatory in 1998[26]. According to findings from the Turkey Demographic and Health Survey, the household utilization of iodized salt rose from 70.2% in 2003 to 85.3% in 2008 across the country[27]. As per the Turkey Nutrition and Health Survey 2017 data, 83.9% of individuals aged 15 and above reported consuming iodized salt[28]. In this study, it was determined that 64.9% of the participants used iodized salt. Nevertheless, the frequency of individuals with urinary iodine level >13.5 μg/dL was higher among those who used iodized salt. A study found that there was a tendency for higher urinary iodine levels in individuals who consumed iodized

Figure 1. Median urinary iodine level classification according to iodized salt use (%).



salt compared to those who did not. However, when adjustments were made for various factors, there was no significant difference between the groups[22]. Similarly, studies conducted on pregnant women found no significant difference in urinary iodine levels based on iodized salt usage[29,30]. The differences in the study results may be associated with variations in iodized salt consumption practices. To prevent iodine loss in salt, it is recommended that it be stored in a dark-colored jar, away from light, consumed within 3 months, and discarded after cooking[31]. However, differences in iodine intake through diet may also affect the results.

This study has some limitations. A significant portion of the sample (88.8%) resides in urban areas, and nearly half are university graduates. The study analyzed individuals' iodine levels using spot urine samples from a single sample. Analyzing multiple samples could provide more accurate results in estimating iodine status.

CONCLUSIONS

The results of this study indicate that iodine status among adult individuals in Amasya is adequate, and the use of iodized salt is widespread. Therefore, it is considered important to continue iodine prophylaxis programs implemented as public health measures. The variations in BMI and alcohol consumption status according to iodine levels suggest that future increases in obesity prevalence may lead to iodine deficiencies. In future studies, it is recommended to evaluate iodine status in risky groups such as children and pregnant women.

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AUTHORS' CONTRIBUTIONS

Conceptualization: M.Ç.; methodology: C.M.-I., M.Ç; formal analysis: C.M.-I.; investigation: C.M.-I.; writing - original draft: C.M.-I.; supervision: M.Ç.

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