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Assessment of Iodine Content in Table Salt Used by Patients with Thyroid Disorders in the City of Tobruk, Libya

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Abstract

According to the World Health Organization, about 2.4% of the world's population still suffers from iodine deficiency despite global efforts. Iodine deficiency remains a major public health problem worldwide, and iodized salt is an effective strategy for preventing thyroid disorders. The results of this study show that there is a large discrepancy in the iodine content between the types of table salt used by fifty people with a thyroid disorder in the city of Tobruk, Libya. Some of the most widely used and consumed types of local salt lack iodine, while other types contain concentrations that exceed the permissible limits according to the standards of the World Health Organization. In light of the noticeable increase in the number of cases during the period (2022-2025), women are considered to have the highest percentage and the presence of cases among children and adolescents. In general, the results confirm the strengthening of health control over table salt in the city of Tobruk, and the imposition of a commitment to fortifying salt with iodine within standard limits, in addition to intensifying health awareness programs at the community level and conducting extensive epidemiological studies.

Keywords: Iodised salt, thyroid disorders, iodine deficiency, food control, health, Libya and the city of Tobruk.

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تقييم محتوى اليود في ملح الطعام المستخدم من قبل مرضى اضطرابات الغدة الدرقية في مدينة طبرق، ليبيا

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ملخص

وفقًا لمنظمة الصحة العالمية، لا يزال حوالي 2.4٪ من سكان العالم يعانون من نقص اليود على الرغم من الجهود العالمية المبذولة. لا يزال نقص اليود مشكلة صحية عامة كبيرة في جميع أنحاء العالم، ويعد الملح المدعم باليود إستراتيجية فعالة للوقاية من اضطرابات الغدة الدرقية. تظهر نتائج هذه الدراسة وجود تباين كبيرة في محتوى اليود بين أنواع الملح الطعام المتداولة لدى خمسين شخص لديهم اضطراب بالغدة الدرقية بمدينة طبرق ليبيا حيث تفتقر بعض أنواع الملح المحلي الأكثر تداولا واستهلاكا إلى اليود بينما تحتوي الأنواع الأخرى على تركيز تتجاوز الحدود المسموح بها وفقا لمعايير منظمة الصحة العالمية وفي ظل الارتفاع الملحوظ في عدد الحالات خلال فترة (2022–2025) تعتبر النساء أعلى نسبة ووجود حالات بين الأطفال والمراهقين. وبوجه عام تؤكد النتائج إلي تعزيز الرقابة الصحية على ملح الطعام في مدينة طبرق ، وفرض الالتزام بتدعيم الملح باليود ضمن الحدود المعيارية إلي جانب تكثيف برامج التوعية الصحية على مستوى المجتمع وإجراء دراسات وبائية موسعة

الكلمات الرئيسية: الملح الدعم باليود، اضطرابات الغدة الدرقية، نقص اليود، مراقبة الأغذية، الصحة، ليبيا ومدينة طبرق.

Introduction:

Iodine is an essential mineral in our diet for ensuring good health and normal growth and development of the body. A healthy human body typically contains between 15–20 mg of iodine, 70–80% of

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which is stored in the thyroid gland (Prodhan et al., 2014). The role of iodine in the thyroid gland is to produce the hormones T3 (triiodothyronine) and T4 (thyroxine), which contribute to regulating hormonal balance in the body and reducing various health problems (Rahman, 2015). These hormones are essential for maintaining metabolism, regulating body temperature, facilitating digestion, supporting mental and sexual development, and maintaining a healthy weight (Obregon et al., 2005). Iodine deficiency can lead to hypothyroidism and many other health disorders. The process of adding iodine to salt involves incorporating trace amounts of iodine into salt to ensure adequate intake in the diet. Iodine fortification of salt has been extensively studied and widely implemented as a public health measure. This method is low-cost and scalable, allowing it to reach large populations through existing distribution networks. It has been considered one of the most successful public health interventions of the 20th century, contributing significantly to reducing the prevalence of iodine deficiency disorders in many countries (World Health Organisation, 2023). Numerous studies have shown that iodising salt can significantly reduce the prevalence of iodine deficiency among the population. A systematic review and meta-analysis of 1,116 studies found that iodising salt clearly reduced the prevalence of goitre, mental retardation (cretinism) and hypothyroidism in Ethiopia (Kabthymer et al., 2021). Therefore, it is important to ensure that the body receives sufficient iodine through the consumption of iodised salt to maintain good health and optimal well-being. Since natural foods typically contain low levels of iodine that are insufficient to meet the body's needs, table salt is fortified with iodine to meet this essential requirement.Children and pregnant women are most vulnerable to micronutrient deficiencies, especially iodine and iron (Modupe et al., 2019). A study conducted in Tanzania found that iodising salt reduced the prevalence of goitre from 43.3% to 5.5% in just three years (Assey et al., 2009). Another study in India found that salt fortification significantly improved

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the iodine status of pregnant women (Kant et al., 2017). In addition, several studies in Ethiopia have indicated that lack of salt fortification was a major factor in high rates of iodine deficiency (Hiso and Roba, 2019; Desta et al., 2019). Furthermore, the improvement in cognitive development resulting from adequate iodine intake could reduce economic losses by approximately US$33 billion (Gorstein et al., 2020). In light of the above, this study aimed to determine the causes of high rates of thyroid disease in the city of Tobruk by estimating the iodine content in table salt. The study included an analysis of the four types of table salt most commonly consumed locally.

Sample preparation:

Fifty cases of thyroid disorders were collected from the city of Tobruk, including 12 males and 38 females aged between 4 and 72 years, as shown in Table 1. Their salt consumption was collected and the iodine content was estimated.

Table(1):Thyroid disorders in fifty samples under study:

N0	Gender	Age	TSH	T4	T3	Gland type
1.	Male	25	8.1	52.77	0.71	Hypothyroidism
2.	Female	40	0.001	11	4.9	Thyroid gland activity
3.	Female	37	12.5	46.33	0.60	Hypothyroidism
4.	Female	28	5.03	4.8	1.12	Hypothyroidism
5.	Male	19	1.17	64.77	1.85	Normal range
6.	Female	18	9.8	54.05	0.75	Hypothyroidism
7.	Female	44	7.0	59.20	0.82	Hypothyroidism
8.	Female	21	182.2	49.9	1.53	Hypothyroidism
9.	Female	60	14.9	39.90	0.57	Hypothyroidism
10.	Female	70	7.4	85	1.6	Hypothyroidism
11.	Female	45	10.1	65	1.6	Hypothyroidism
12.	Female	27	2.30	140.29	1.93	Normal range
13.	Female	57	0.12	111.22	1.29	Normal range

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N0	Gender	Age	TSH	T4	T3	Gland type
14.	Female	60	8.16	109.46	1.69	Hypothyroidism
15.	Female	35	38.00	8.61	1.49	Hypothyroidism
16.	Female	4	12.0	0.5	2.6	Hypothyroidism
17.	Female	21	10.4	50.19	0.68	Hypothyroidism
18.	Female	31	1.48	128.10	1.91	Normal range
19.	Female	55	11.6	45.05	0.63	Hypothyroidism
20.	Female	50	2.85	89.91	1.84	Normal range
21.	Female	33	6.8	61.78	0.85	Hypothyroidism
22.	Male	50	2.46	61.12	1.60	Normal range
23.	Female	48	13.3	41.18	0.59	Hypothyroidism
24.	Female	22	1.9	91	2.0	Normal range
25.	Male	40	0.3	102	0.18	Thyroid gland activity
26.	Female	62	15.5	34.75	0.51	Hypothyroidism
27.	Male	56	5.5	81	1.6	Hypothyroidism
28.	Female	30	5.36	3.99	1.93	Hypothyroidism
29.	Female	22	3.55	91.81	1.76	Normal range
30.	Female	30	12.0	46.33	0.66	Hypothyroidism
31.	Male	25	0.11	14.14	4.01	Normal range
32.	Male	29	9.2	51.48	0.73	Hypothyroidism
33.	Female	68	3.94	106.98	1.78	Normal range
34.	Male	51	24.75	62.09	4.85	Hypothyroidism
35.	Female	28	5.2	2.2	129.2	Hypothyroidism
36.	Male	70	1.94	92.57	1.81	Normal range
37.	Male	31	4.94	70.87	4.48	Hypothyroidism
38.	Female	57	0.10	88.99	1.39	Normal range
39.	Female	14	7.6	56.63	0.78	Hypothyroidism
40.	Female	25	0.84	97.99	1.75	Normal range
41.	Female	62	8.55	65.64	1.50	Hypothyroidism
42.	Female	70	10.1	48.93	0.69	Hypothyroidism
43.	Female	39	4.24	61.14	0.77	Normal range
44.	Female	8	8.3	55.34	0.76	Hypothyroidism
45.	Female	38	2.25	09.96	.74	Normal range
46.	Male	19	.22	92.37	2.15	Normal range
47.	Female	41	0.703	140.04	2.00	Normal range
48	Male	63	2.09	89.10	1.93	Normal range
49	Female	33	10.10	77.17	2.06	Hypothyroidism
50	Female	19	2.59	65.08	1.58	Normal range

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Materials and method:

The iodine content in table salt samples was determined using the AOAC (1984) method, which is based on iodometric titration.

Sample preparation: Weigh 10 g of salt in a 250 ml conical flask, add 50 ml of distilled water, and dissolve thoroughly. Add 1 g of potassium iodide (KI) to the solution, then acidify the medium by adding 5 ml of 1% concentrated sulphuric acid to release free iodine from iodide ions (this step is carried out in the absence of light and under low humidity conditions to avoid decomposition or loss of iodine), according to equation (1).

$$IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O \qquad (1)$$

Titration: The released iodine was titrated directly using a sodium thiosulphate ($Na_2S_2O_3$) solution until the solution turned light yellow, according to equation (2).Two millilitres of starch solution were added as a colour indicator, and the titration was completed.

$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-} \qquad (2)$$

The titration was repeated three times for each salt sample, and the average was The iodine concentration in the table salt sample was calculated according to the following equation:

$$\frac{1000 \times 126.9 \times m(\text{thiosulfate}) \times V(\text{blank} - \text{sample})}{(g)\text{swample wight}}$$

- V= volume of sodium thiosulfate (L)
- m = concentration of sodium thiosulfate solution
- 126.9 = atomic mass of iodine (g/mol)

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Table (2) shows the types of salt consumed in 50 cases of thyroid disorder and their iodine concentration.

Type of salt:	Iodine percentage(ppm):
Local salt	0
Acacus salt	69.8ppm
Lighthouse salt	0
Salt of the hour	111.54 ppm

Statistical analysis

Perform statistical data analysis for the years 2022-2025 using Microsoft Excel. The graph was created in Figure (1).

Results and Discussion:

This study assessed the iodine content of several brands of table salt consumed by 50 patients diagnosed with thyroid disorders in the city of Tobruk, Libya, as it is the primary dietary source of iodine and the most widely consumed food vehicle. The results showed a noticeable variation in the concentration of iodine in the types of salt consumed. The local salt, which is the most widely consumed due to its low price and prevalence in the markets, does not contain detectable iodine. This observation is important given the essential role of iodine in the synthesis of thyroid hormones. Akakus salt contained a high concentration of iodine at 69.8 mg/kg, which exceeds the approved range in nutritional standards (25-65 ppm). It was also shown that local salt, Al-Manara salt, is devoid of iodine, while hourly salt, despite containing a high concentration of iodine at 111.54 parts per million, exceeds the permissible limit set by the World Health Organization (WHO) (15-40 ppm) and is in violation of quality standards. The product can contain 35-45 ppm. It is considered an excess because consuming excess iodine carries the risk of developing hypothyroidism or hyperthyroidism. Previous studies have indicated that excessive iodine intake may be associated with imbalances in thyroid function, including hypo- or hyperthyroidism. However, the current study does not allow for the evaluation of this relationship due to the failure to measure individual iodine intake and the lack of control for confounding

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factors. Statistical data were collected from the Diabetes and Endocrinology Center in the city of Tobruk for the period 2022-2025. An increase in the number of cases of thyroid disorders in both males and females is shown in Figure 1.

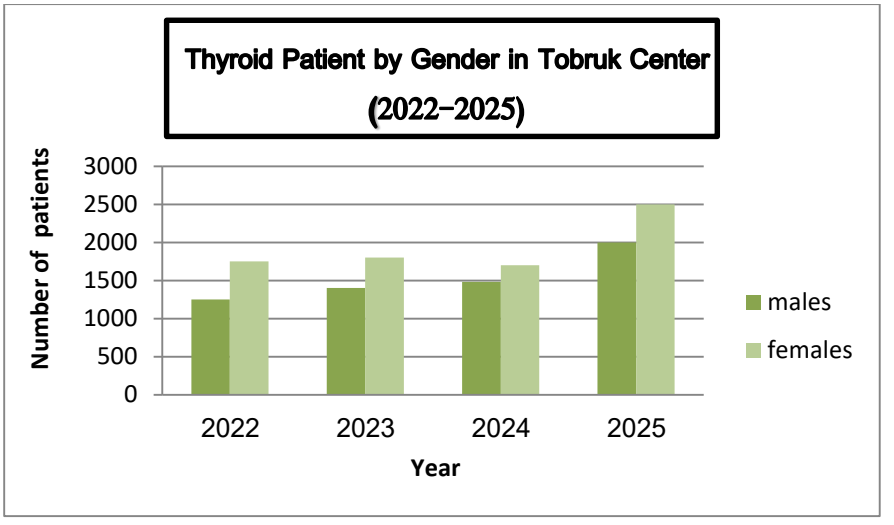

Fig 1.Graphic analysis of the prevalence of thyroid disorders from 2022 to 2025 in Tobruk city.

The number of infections increased from 3,000 cases in 2022 to 4,300 cases in 2025. This increase represents a worrying trend. The results highlight the presence of significant variation in iodine content between the types of table salt traded in the city of Tobruk and confirm the need to strengthen control over the iodisation of salt and raise the level of health awareness among the population. However, more comprehensive epidemiological studies, including control groups and statistical analysis, are needed to control confounding factors. It is necessary to clarify the relationship between the iodine content in salt and thyroid disorders, as the recommended daily amount of iodine is 150 micrograms for adolescents and adults, 250 micrograms for pregnant and breastfeeding women, and 120 micrograms for children aged 6 to 12 years. It is estimated that about two billion people around the world are at risk of insufficient intake of iodine (Andersson et al., 2012). The study showed that women account for the largest percentage of cases of thyroid disorders at 70%. This is a result of

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hormonal changes in women, especially in the age groups between 30 and 60 years, as well as the presence of cases in children and adolescents, which indicates the existence of extended problems of malnutrition or poor health awareness. We also notice that genetic predisposition, combined with poor nutritional awareness, may contribute. Early on, it is recommended that all table salt be supplemented with iodine to prevent intellectual and developmental disabilities (IDDs) (2014, WHO). These results also support previous studies conducted in other countries. A study in South Africa showed that the iodine level was less than 20 parts per million in 12 producers, which represents about 34.8% of the total producers (Jooste, 2003). Also, a study in northwestern Ethiopia showed that 61.54% of the samples collected were from family and school, spreading the culture of health awareness in schools and society because thyroid disorders impact the educational level of children. The World Health Organization also reported insufficient iodine levels. It was found that the distribution of iodine within these samples is not homogeneous (Bediye and Berihae, 2015). In the United States, it was found that the iodine content differed in five samples taken from the same container but from different depths (Dasgupta et al., 2008).

Recommendations

Strengthening control over food salt in the city of Tobruk and obliging all factories and suppliers to standardize the concentration of iodine in table salt within the permissible World Health Organization standards. Improving quality procedures during production, storage and distribution of salt to reduce or increase the loss of iodine. Implementing health awareness programs for the most vulnerable groups, women and children. Supporting diabetes and endocrine centers with programs for monitoring and periodic follow-up of thyroid disorders and linking clinical data to nutritional and environmental indicators. Conducting comprehensive future epidemiological studies to measure dietary intake of iodine and determine its relationship with thyroid disorders.

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