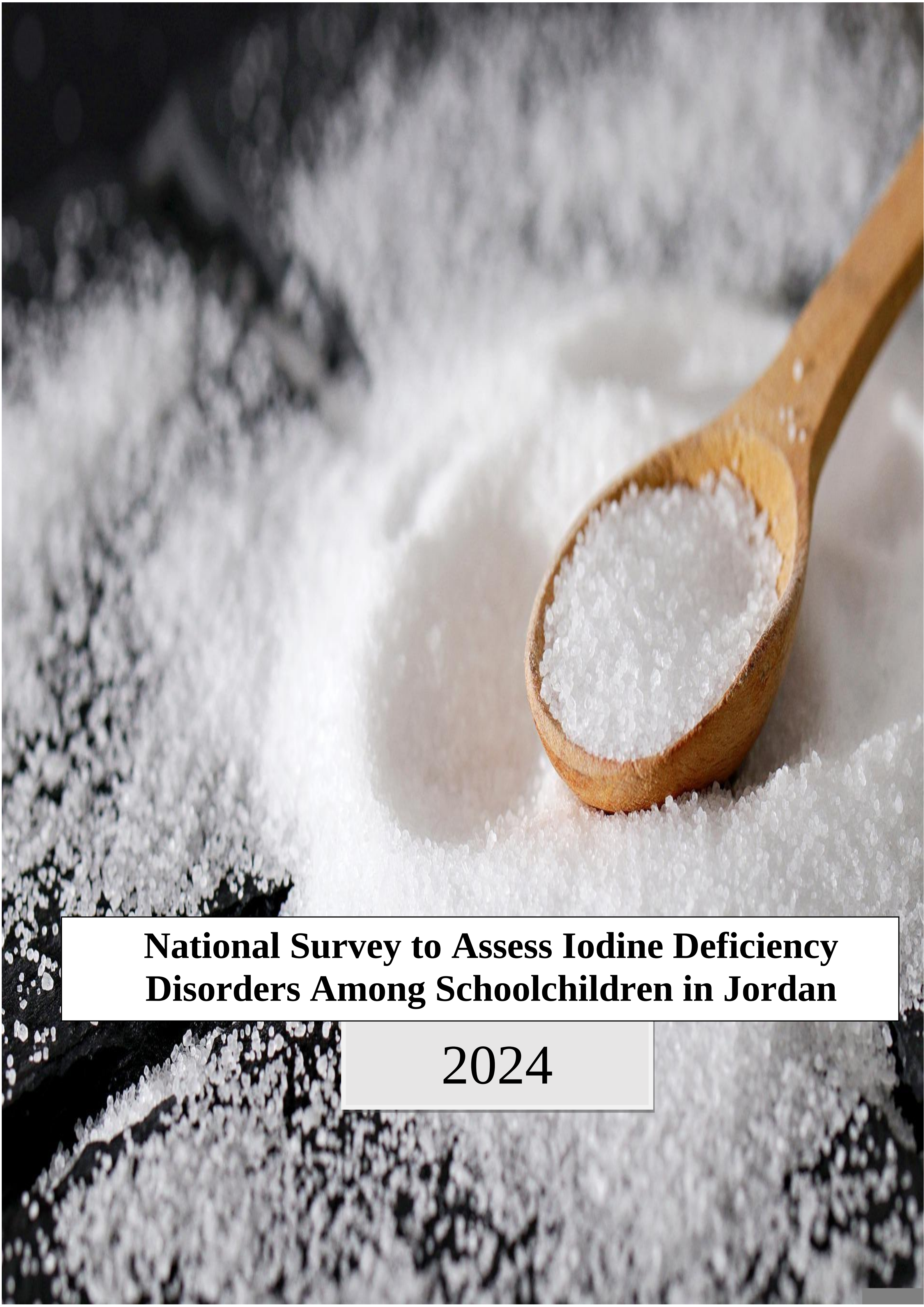

National Survey to Assess Iodine Deficiency Disorders Among Schoolchildren in Jordan

2024

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Preface

Jordan has achieved a dramatic improvement in iodine status in recent decades. It has been making steady progress toward the elimination of iodine deficiency disorders (IDD), which was accompanied by a sharp decrease in the prevalence of goitre among school-aged children. Mandatory salt iodization was introduced in 1995. The Ministry of Health initiated a monitoring and evaluation program in 2000 and has been successful in implementing an effective, functional national program for the iodization of salt, including legislation, regulations, political commitment, a national program committee, regular monitoring procedures, mandatory reporting, public education, and social mobilization. At the national level, Jordan is free from IDD.

The Ministry of Health, in collaboration with ACDIMA Biocenter, has implemented a national survey to assess iodine deficiency disorders among school-age children in Jordan (IDD 2024) and monitor the effects of the intervention on the iodine status of a population.

The Ministry of Health is grateful for the financial support from the European Union (EU) in collaboration with the Spanish Agency for International Development Cooperation (AECID).

The Ministry of Education and Department of Statistics (DOS) are particularly acknowledged for their coordination and for facilitating access to the survey population.

We are also grateful to the many individuals who dedicated tireless hours to data collection. First and foremost, we thank the thousands of schoolchildren and their parents who participated in the survey.

We also thank the field workers (supervisors, lab technicians, and general practitioners) who conducted the fieldwork despite the many challenges encountered on the ground, as acknowledged on page (4) and Appendix II.

Prof. Feras Al-Hawary

Minister of Health , Jordan

List of Abbreviations, Acronyms, and Symbols

ACDIMA	The Arab Company for Pharmaceutical Industries and Medical Supplies
AECID	The Spanish Agency for International Development Cooperation
ºC	Celsius degree
EU	Europe Union
IDD	Iodine Deficiency Disorders
ICCIDD	The International Council for the Control of Iodine Deficiency Disorders
ICN	The International Conference of Nutrition
JISM	Jordanian Institution for Standards and Metrology
Kg	Kilogram
L	Liter
Mg	Milligram
µg	Microgram
mL	Milliliter
MOE	Ministry of Education
MOH	Ministry of Health
ppm	part per million
PPS	Probability Proportional to Size
PSU	Primary Sampling Unit
p-value	Probability Value
SPSS	Statistical Package for Social Sciences
TGR	Total Goitre Rate
TSH	Thyroid Stimulating Hormone
UNICEF	The United Nations Children's Fund
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
MUIC	Median Urinary Iodine Concentration
USI	Universal Salt Iodization
WHO	World Health Organization

1. Executive Summary

1.1. Overview of the Study

Iodine deficiency causes a spectrum of disorders, from poor growth, retarded development, low urinary iodine excretion, poor cognitive function, and goitre, to severe cognitive disability and death. Consistent consumption of small quantities of iodine can prevent these disorders and reverse some, but not all, of the negative effects of iodine deficiency. In 1993, the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) recommended universal iodization of salt to prevent and treat iodine deficiency disorders, and this recommendation remains today. Salt (table salt, sodium chloride) is a good vehicle for iodization because it is consumed almost universally without seasonal variation; there are relatively few production facilities and simplified quality control; technology for iodization is well established; consumer acceptability of iodized salt is high; and iodization is very inexpensive. This study aimed to assess the effectiveness of the national salt iodization program on Jordanian children following the reduction of iodine levels in iodized salt from 40–60 mg/kg to 20–40 mg/kg. This adjustment was made in response to findings from the 2010 National Survey to Assess Iodine Deficiency Disorders (IDD) among Jordanian children, which reported cases of hyperthyroidism in some governorates.

Survey Goal and Objectives: Assessing the effects of the national salt iodization program on the Jordanian children through:

- Measuring the median urinary iodine concentration (MUIC) among schoolchildren aged 8–10 years.
- Conducting clinical examinations for goitre.
- Evaluating the implementation progress of the IDD control program by assessing the consumption of adequately iodized salt at the household level.

1.2. Study Design:

The Iodine Deficiency Disorders 2024-study was designed as a national cross-sectional survey. It was conducted on 5327 schoolchildren aged 8-10 (3rd, 4th, and 5th grades) who were randomly selected from 533 public, private, and UNRWA schools.

1.3. Study Results:

Table 0 summarizes the results of the IDD Survey 2024 in Jordan on schoolchildren aged 8-10 years.

Table 0: Summary results of the IDD Survey 2024 in Jordan on schoolchildren aged 8-10 years,

Province	Prevalence of goitre (%)	MUIC (µg/L)	Household consumption of iodized salt (%)
Central	6.9	125	99.8%
North	7.8	140	99.6%
South	7.4	136	98.6%
Total	**7.3**	**130**	99.5%

1.4. Discussion

The findings of the survey revealed that the total prevalence of goitre was 7.3%, with the highest prevalence being in the north and the lowest being in the central region. The prevalence is higher among females than males (7.8% and 6.9%, respectively), with goitre grade one constituting about 7.2%, while it is 0.1% for grade two. Ajloun has the highest prevalence of goitre in general (24.8%) and in grades one and two (23.9 and 0.9%, respectively). At the same time, the Madaba governorate did not record any cases of goitre, and the prevalence rate was 0%.

The overall median urinary iodine concentration was 13.0 (µg/100 mL), which is considered to be optimal according to WHO/ICCIDD classification (10.0-19.9 µg/100 mL). The median iodine concentrations range from 12.0 µg/100 mL (Zarqa) to 14.0 µg/100 mL (Irbid, Jerash, Ajloun, Ma'an). The slight variations reflect differences between governorates, but all remain within the optimal threshold. Almost (99.5%) was the proportion of households consuming effectively iodized salt.

While global data reveal excessive iodine intake (UIC ≥300 µg/L) in 12 countries—including Qatar (341 µg/L, 2014) as the sole Arab nation—other regions face deficiencies. Among Arab countries, Lebanon (66 µg/L, 2013) and Iraq (84 µg/L, 2011–12) exhibit insufficient iodine intake in school age children, falling below the WHO threshold (100 µg/L). In contrast, Jordan's 2024 survey demonstrates optimal iodine status (130 µg/L), reflecting successful salt iodization. However, Jordan's regional disparities (e.g., high goitre rates in Ajloun) underscore the need for targeted monitoring.

1.5. Strengths and Limitations

The National Survey to Assess Iodine Deficiency Disorders in Jordan demonstrates several key strengths, including its nationwide representativeness, covering all governorates, and ~~its use~~ incorporates of quantitative impact indicators of a clinical assessment of goitre and urine iodine levels. to assess the magnitude of IDD as a public health problem and to monitor the effects of the intervention on the iodine status of a population that helps to describe a situation that exists, and can be used to track changes in the situation over time that can map the geographic distribution of the public health problem of iodine deficiency to emphasize the monitoring of iodized salt to be fully effective in correcting iodine deficiency and to ensure that iodized salt delivery systems reach all affected populations, including those in greatest need. Compared to other study designs, cross-sectional surveys are often more cost-effective for gathering large-scale data, making them practical to measure the impact of the national iodized salt program. Finally, the survey provides an ideal assessment of iodine status and a concurrent assessment of household use of iodized salt. This provides information on both the likely iodine intake and iodine status, making it easier to distinguish between difficulties with iodized salt quality and iodized salt use. When adequately iodized salt is used, this should be reflected in adequate iodine status in the population sampled, which indicates the impact and the effectiveness of the intervention on the iodine status of a population.

Despite these advantages, several limitations must be considered. Thyroid palpation for goitre is suitable for baseline assessments but is much less reliable for determining impact. Moreover, its specificity and sensitivity are low for grades 0 and 1 due to high inter-observer variation, leading to a high risk of misclassification in detecting mild goitre. Accordingly, it is recommended that urinary iodine be used to monitor the impact. Additionally, the cross-sectional nature of the survey limits the ability to establish causality or assess changes over time, periodic reassessment of IDD indicators using valid and reliable methods, including measurement of urinary iodine levels and analysis of the salt situation, should be applied while keeping costs to a minimum.

To strengthen future monitoring, it is recommended to prioritize UIC as the primary impact indicator, supported by salt iodine testing, including the use of rapid field kits. A triangulated approach, combining clinical, biochemical, and household-level data, is crucial for identifying discrepancies such as Ajloun's high goitre rates despite optimal median UIC. Finally, conducting regular reassessments every 3–5 years will be essential to evaluate the long-term sustainability and equity of Jordan's salt iodization program.

2. Introduction

2.1. Public Health Overview

Iodine deficiency, one of the most prevalent micronutrient deficiencies globally, is the main cause of potentially preventable cognitive disability in childhood (1). Iodine is a trace element in the human body and is absorbed through the gut as iodide, the chemically bound form of iodine. The iodine content of food depends on the soil in which it is grown. Iodine in the soil is often leached out by repeated flooding and glacial activity and carried to the sea, thereby making seawater, seaweed, and marine fish rich sources of iodine. Because iodine is an essential constituent of the thyroid hormones thyroxin (T4) and triiodothyronine (T3), iodine deficiency can have a profound effect on their production. Goitre, a manifestation of thyroid hyperplasia and increased thyroid vascularity, results from a compensatory increase in the release of thyroid-stimulating hormone (TSH) as a result of low T4 levels and is traditionally detected and evaluated using inspection and palpation. The prevalence of goitre increases with the severity of iodine deficiency and becomes endemic in populations where the intake of iodine is less than 10 µg per day. Persistent iodine deficiency can eventually affect growth and mental development in all age groups (1).

When iodine requirements go unmet, the synthesis of thyroid hormones is impaired, resulting in a spectrum of growth and developmental and functional abnormalities, which are referred to as iodine deficiency disorders (IDD). Goitre, swelling of the thyroid gland, is the most common manifestation of iodine deficiency in both children and adults. Severe iodine deficiency during pregnancy results in fetal death or cretinism, marked by severe mental and physical growth retardation. Mild and moderate deficiency during pregnancy hinders fetal development and puts offspring at high risk of speech and hearing defects and impaired motor and physical growth. Iodine deficiency during infancy and early childhood can also cause irreversible deficits in cognitive development [1].

2.2. How is iodine deficiency identified?

Although goitre assessment by palpation or ultrasound may be useful for assessing thyroid dysfunction, results are difficult to interpret once salt iodization programs have started. The MUIC is considered to be the main indicator of iodine status for all age groups because its measurement is relatively non-invasive, cost-efficient, and easy to perform. Since most of the iodine absorbed by the body is excreted in the urine, it is considered to be a sensitive marker of current iodine intake commonly measured in schoolchildren aged 6-12 years because it is easy to access this population.

For schoolchildren (≥ 6 years of age), an adequate iodine level is defined as a population MUIC of 100-199 µg/L, whereas a population median of <100 µg/L indicates that the population's iodine intake is insufficient. When the population median is <20 µg/L, the population is described as having severe iodine deficiency; at 20-49 µg/L, it is described as having moderate iodine deficiency; and at 50-99 µg/L, it is described as having mild iodine deficiency and can reflect recent changes in iodine status. The MUIC has been the highest. A population of schoolchildren should have a MUIC of at least 100 µg/L, with less than 20% of values being <50 µg/L. For pregnant women, the median urinary iodine should be between 150 µg/L and 249 µg/L. [2]

2.3. The global concern of IDD

The World Summit for Children held in New York in September 1990 called for the virtual elimination of iodine deficiency disorders by the year 2000. The goal of elimination was also included in the plan of action adopted by the International Conference on Nutrition (ICN, Rome, 1992)[3]. In 1993, WHO and UNICEF recommended universal salt iodization (USI)1 as the main strategy to achieve elimination of IDD. The elimination of IDD is a critical development issue and should be given the highest priority by governments and international agencies. In 2005, the importance of IDD elimination was again recognized when the World Health Assembly adopted a resolution committing to reporting on the global IDD situation every three years. [2]

The World Health Organization (WHO) estimates that approximately 37% of schoolchildren, 285 million and nearly 2 billion individuals worldwide, have insufficient iodine intake. Mountainous areas are particularly susceptible to iodine deficiency, owing to low levels of iodine in the soil and, thus, the locally grown and raised food. However, iodine deficiency is common in many contexts globally and is considered a public health problem in more than 50 countries. WHO, the United Nations Children’s Fund (UNICEF), and the International Council for the Control of Iodine Deficiency Disorders Global Network (ICCIDD) promote salt iodization for the control of iodine deficiency disorders because (i) salt is widely consumed by virtually all population groups in all countries, with little seasonal variation in consumption; (ii) salt production is generally limited to a few canters, facilitating quality control;

(iii) technology for salt iodization is well established and relatively easy to transfer to less developed countries; (iv) iodization does not affect the organoleptic properties of salt and, therefore, consumer acceptability is high; and (v) iodization is very inexpensive. To date, more than 120 countries with all levels of deficiency risk are implementing large-scale salt iodization. Despite the known benefits of appropriate consumption of iodine, some concern exists that widespread salt iodization could potentially lead to excess iodine intake. Furthermore, though policies to support salt iodization and reduce sodium intake are compatible, there is concern that, as populations reduce salt intake to reduce the risk of elevated blood pressure, hypertension, and stroke, there may be an increase in iodine deficiency disorders (1).

2.4. Background in Jordan

In the last decades, three national studies related to IDD in Jordan have been documented: The first was performed in 1993 before the implementation of the IDD control program, the second in 2000 after its implementation, and the third in 2010.

The 1993 study:

A random selection of 2749 children 8-10 years of age (52%boys and 48% girls) was made by PPS (probability proportional to size) in 8 governorates; 79% were in 3 Governorates of Amman, Zarqa, and Irbid. Urinary iodine content was determined in 270 schoolchildren. The results revealed that the prevalence of goitre in schoolchildren was 37.6% (from 10.9% to 76.1% in various governorates), which existed in moderate and severe degrees. Therefore, the IDD control Program was decided to start. According to records of the Nutrition Section of the Ministry of Health, the efforts began in 1993; political commitment was made, and a control program using universal salt iodization was adopted. However, iodized salt was not produced in Jordan and distributed throughout the country until 1995. Therefore, Jordan has adopted WHO/UNICEF/ICCIDD criteria for monitoring its program towards the sustainable elimination of IDD since 1995.

There are no data available regarding the frequency of iodized salt consumption from 1995 to 1997; a rapid survey using rapid kits showed that 95% of the households consumed iodized salt (The method of assessment is not available). The regular monitoring program began in 1998, using quantitative measurements of salt obtained randomly from shops (sellers) on a three-month basis in all governorates. Internal quality assurance and external inspection by the IDD committee in the salt factories were frequently performed. Inspection and rapid test kits at trader and wholesale levels and other places were performed on an *ad hoc* basis.

In the year 2001, there were four iodized salt factories. The amount of added potassium iodate was 40-60 ppm. The packaging was made of 25kg bags by 15 retailers. Only 5 of these retailers had licenses from the Government, and the rest operated illegally, and there was no control over their activities. Educational programs and strategies were planned and implemented. (5)

The 2000 National Monitoring Survey:

A random selection of 2601 schoolchildren aged 8 to 10 years was done with PPS throughout the country. Urine samples were collected from all individuals. The national study conducted by the MOH, UNICEF, and WHO in 2000 showed that goitre prevalence among schoolchildren reduced from 37.7% to 34%. Despite this positive change, much progress remains to be made to eliminate iodine deficiency disorder.

According to that national study, the most important criterion for monitoring progress towards sustainable elimination of IDD is the MUIC in schoolchildren equal to or higher than 10 µg/100 mL. The national study revealed that 11% of Jordanian students had a median below five µg/100 mL. The study also showed that 25% of the study population received insufficient iodized intake, about 47% received adequate intake, and the rest of the students received either more than sufficient or excessive intake (29%).

The same study revealed that household consumption of Iodized salt was 86%, which was below the perfect statistic (>90%, WHO, criteria)[8], caused by the continued availability of unionized salt in the market. Thus, it was recommended to monitor the biological impact of the program on the population every 5 years to evaluate the effectiveness of the intervention program.

It was concluded that moderate and severe IDD existed before 1993 in Jordan. A review of available data shows that Jordan was successful in the implementation of a baseline assessment of IDD in 1993, adopted an IDD Control Programme in 1995, and completed a monitoring and evaluation program in 2000. Furthermore, there was a significant increase in goitre prevalence because marked differences in the prevalence of the disease usually take five to ten years to manifest themselves after the introduction of iodized salt. [(4)]

A National Survey to assess iodine deficiency disorders (IDD) among Jordanian children 2010:

It was conducted on 4,600 schoolchildren aged 8-10 who were randomly selected from the primary public, private, and UNRWA schoolchildren in the 3rd, 4th, and 5th grades. The indicators used for this study were the measurement of the MUIC, a clinical examination of the goitre, and the proportion of households consuming iodized salt.

The 2010 survey aimed to evaluate the effectiveness of the iodization program; the findings of the 12 governorates are pooled into three regions (middle, north, and south) of the country for the sake of giving more validity for comparisons for both clinical and biochemical indicators, there was a significant improvement for all region in 2010 when compared with 2000 study for the prevalence of goitre (the overall prevalence rate of goitre found to be 4.9% compared to 33.5%in 2000), while there was a risk of iodine-induced hyperthyroidism in the middle and north region. It was an optimal intake of iodine in the south region. (reference)

The 2010 survey described the distribution of MUIC (µg/100 mL) in different governorates; the overall median iodine concentration for this study was 20.9, which was considered to be a risk of iodine-induced hyperthyroidism, compared with the 2002 survey, which was 15.4, which is supposed to be optimal intake. Amman, Balqa, Zarqa, Madaba, Irbid, and Mafraq showed a risk of iodine-induced hyperthyroidism. On the other hand, Ajloun, Jerash, Karak, Tafilah, Ma'an, and Aqaba showed an optimal intake of iodine. (5)

The findings of the survey showed that 96.3 of the sample consumed iodized salt, which fulfills the recommendation of WHO (at least 90% of households are using salt with an iodine content of 15 parts per million (ppm) up to 40 ppm.

3. Survey Goal and Objectives

3.1. Objectives

Assessing the effects of iodization programs on the Jordanian population by:

- Measuring the median urinary iodine concentration (MUIC) among schoolchildren aged 8–10 years.
- Conducting clinical examinations for goitre.
- Evaluating the implementation progress of the IDD control program by assessing the consumption of adequately iodized salt at the household level.

3.2. Rationale for this Survey/Study

A national survey to assess iodine deficiency disorders (IDD) among Jordanian children 2010 survey was conducted to evaluate the effectiveness of the iodization program, and it was evident from findings of this survey an increment in median iodine concentration which pointed out that the study population receive an adequate or excessive intake of iodine through salt iodization program which is considered to be risk of iodine – induced hyperthyroidism according to WHO/ICCIDD classification (20.0-29.9 microgram/100ml risk of iodine –induced hyperthyroidism within 5 to 10 years following abrupt introduction of iodized salt in susceptible groups), the 2010 survey describe the distribution of median iodine concentration in urine (microgram/100ml) in different governorate, the overall median iodine concentration for this study was 20.9 which is considered to be risk of iodine – induced hyperthyroidism, this increment in median iodine concentration can be attributed to a risk intake of high amount of iodine through salt iodization program. (8)

Based on this finding, there was consensus from the higher committee of nutrition in collaboration with JISM to reduce the Iodine level from a dose of 40-60mg/kg to 20-40 mg/kg. WHO/UNICEF/ICCIDD recommend that, in typical circumstances, (where the iodine lost from salt is 20% from production site to household, another 20% is lost during cooking before consumption, and average salt intake is 10 g per person per day), iodine concentration in salt at the point of production should be within the range of 20–40 mg of iodine per kg of salt (i.e., 20–40 ppm of iodine) in order to provide 150 µg of iodine per person per day).

Robust monitoring of salt iodization programmers was important to ensure safe and effective levels of iodine consumption, especially as the country implemented a reduction of iodine levels in salt. Accordingly, the IDD survey 2024 was conducted to evaluate the iodization salt program.

4. Methodology

4.1. Study Population

This study included 5,327 schoolchildren aged 8-10. They were selected conveniently from 533 public, private, and UNRWA schools in the 3rd, 4th, and 5th grades. In fact, those schoolchildren may not represent the same age group in the general population. Still, because school enrollment in Jordan is almost complete in this age group, the representation was considered adequate.

4.2. Sample Frame

The IDD 2024 survey sampling frame was based on the school framework provided by the Ministry of Education. Each school in the governorates (comprised of at least one grade) was considered the primary sampling unit (PSU).

Table 1 shows the distribution of schools by governorate according to the supervising authority. In Jordan, 4,694 schools have at least one classroom in the 3^{rd}, 4^{th}, and 5^{th} grades.

Table 1: Distribution of schools by the governorate and supervising authority.

Governorate	Supervising Authority				Total
	Governmental	Private	UNRWA	Other governmental	
Amman	671	601	12	4	1288
Balqa	226	86	4	1	317
Zarqa	283	177	19	4	483
Madaba	118	44	2	1	165
Irbid	581	287	19	1	888
Mafraq	479	39	2	3	523
Jerash	147	35	5	-	187
Ajloun	106	46	-	-	152
Karak	251	37	-	1	289
Tafilah	100	7	-	1	108
Ma'an	179	9	-	6	194
Aqaba	68	21	-	11	100
Total	**3209**	**1389**	**63**	**33**	**4694**

4.3. Sample Size Determination and Selection

The sample was stratified and selected in two stages, with each governorate considered a stratum. In total, 12 sampling strata were constructed. The required sample size was calculated using the following assumption and definition: the estimated proportion of the population (assume 0.5), the desired precision of 0.05, and response rates of 0.85. The sample size equation used is:

$$n = \frac{N * z^2 * p(1-p)}{d^2 * (N-1) + z^2 * p(1-p)}$$

Where n: Sample size; Z: Z-score (based on the desired confidence level, e.g., 1.96 for 95%); p: Estimated proportion to be estimated in each population domain (assume 0.5); d: Margin of error (e.g., 0.05 for 5%). Samples were selected independently in each sampling stratum via a two-stage selection procedure. In the first stage, 533 clusters (schools) were selected with probability proportional to cluster size. Still, the proportional allocation allocated a sample size that was too small for the small governorates such as Tafiela, Ma'an, and Aqaba. Meanwhile, a proportional allocation allocated an unnecessarily large sample size to the large governorates (relative areas for the different governorates are shown in Figure 1**)**. Proportional allocation cannot meet the precision request of small governorates. In order for the survey precision to be comparable across the governorates, it was decided to use a power allocation with small adjustments, which is between the proportional allocation and the equal size allocation. In the second stage of selection, a fixed number of 10 students per cluster is selected randomly. Each selected child was subjected to both clinical examination and urine testing for iodine concentration.

Table 2 and Figure 2 show the locations and distribution of schools selected by the governorate, according to the supervising authority, respectively.

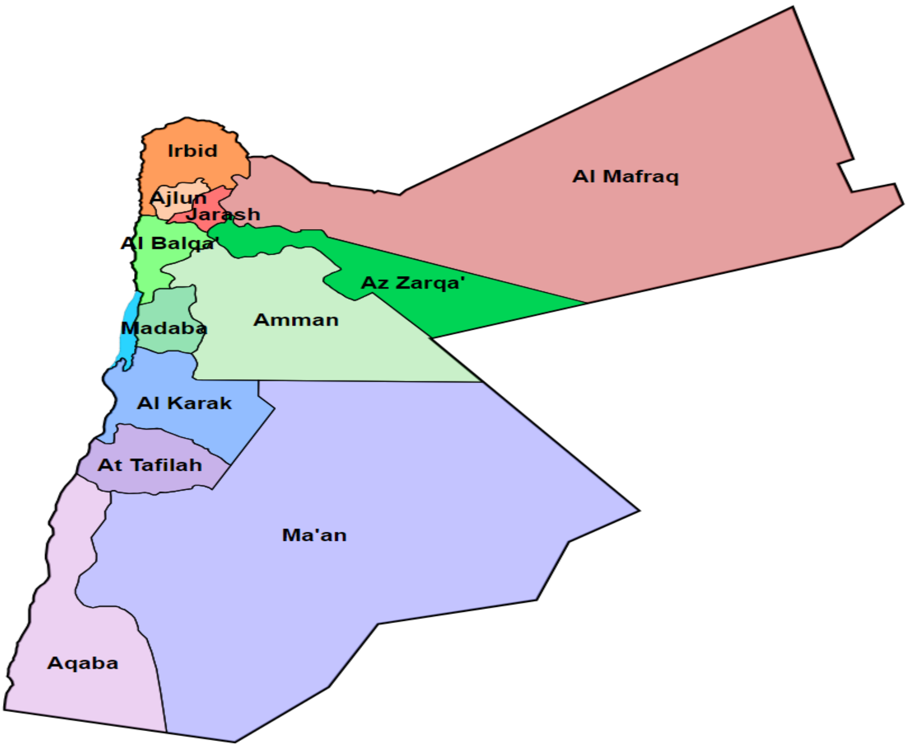

Figure 1: The governorates of Jordan map.

Table 2: Locations of the surveyed schools based on the governorate and supervising authority**.**

Governorate	Supervising authority				Total
	Governmental	Private	UNRWA	Other Governmental	
Amman	66	46	3	2	117
Balqa	29	12	2	1	44
Zarqa	46	16	3	3	68
Madaba	17	7	1	1	26
Irbid	55	20	3	1	79
Mafraq	42	4	2	1	49
Jerash	20	5	3	-	28
Ajloun	16	7	-	-	23
Karak	28	4	-	1	33
Tafilah	16	2	-	1	19
Ma'an	20	1	-	1	22
Aqaba	16	7	-	2	25
Total	**371**	**131**	**17**	**14**	**533**

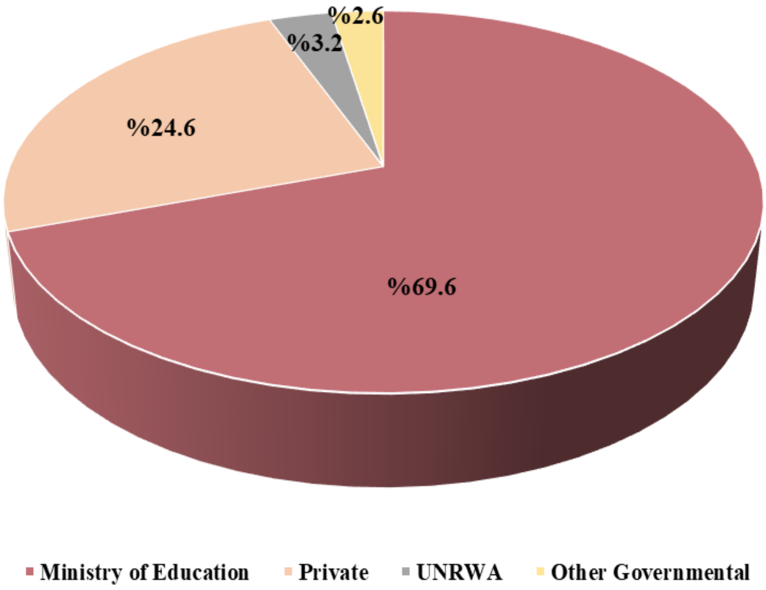

Figure 2: Distribution of the surveyed schools by supervising authority**.**

4.4. Fieldwork

Sample collection was conducted between 13 October and 20 November 2024. Twenty-two field teams were formed to carry out the fieldwork. Each team included one general practitioner, medical technician, and driver. The medical laboratory team from ACDIMA BioCenter managed and supervised the daily activities. Their tasks included monitoring the progress of the fieldwork, receiving the filled forms and urine samples by the end of the day, checking for mistakes, sending the urine samples to the ACDIMA BioCenter medical laboratory unit, and preparing for the next day.

4.5. Measurements and Definitions of Outcomes

There are basically two types of indicators: outcome indicators that provide a measure of IDD status and process indicators that measure the progress made in implementing an IDD control program. Outcome indicators can be categorized according to whether the assessment was clinical (thyroid size, cretinism) or biochemical (urinary iodine and thyroid-related hormones)[6]. Supplementary Table 1 presents the criteria for progress toward the elimination of IDD as a significant public health problem monitoring.

Supplementary Table 1: Criteria for progress towards elimination of IDD as a significant public health problem monitoring

Indicator	Goal
1. **Salt iodization** The proportion of households consuming effectively iodized salt	**>90%**
2. **Urinary iodine** Proportion below 100 µg/mL Proportion below 50 µg/mL	**< 50%** **<20%**
3. **Thyroid Size** In schoolchildren 6-12 years of age: Proportion with enlarged thyroid by palpation or ultrasound	**<5%**

<u>Testing table salt for iodine</u>

To show that an IDD program is sustainable, the WHO has suggested that the availability and consumption of adequately iodized salt is greater or equal to 90% as an indicator. To assess the distribution of inadequately iodized salt, rapid tests were conducted on 100 g salt samples from randomly selected markets within the districts. A 100 g salt sample was collected from both households and local retailers within each cluster chosen area. These samples, collected from each eligible student enrolled in the survey, were then analyzed using rapid test kits to determine iodization levels [8]. Criteria for adequate iodized salt consumption are presented in Supplementary Table 2.

Supplementary Table 2: Criteria for adequate iodized salt consumption.

Indicator	Goal
Salt Iodization The proportion of households consuming effectively iodized salt	**>90%**

4.6. Biochemical indicator for urinary iodine

Most iodine absorbed in the body eventually appears in the urine. Therefore, urinary iodine excretion is a good marker of very recent dietary iodine intake. In individuals, urinary iodine excretion can vary somewhat from day to day and even within a given day. However, this variation tends to even out among populations. Studies have convincingly demonstrated that a profile of iodine concentrations in the morning or other casual urine specimens (child or adult) provides an adequate assessment of a population's iodine nutrition, provided a sufficient number of specimens are collected. Round-the-clock urine samples are difficult to obtain and are not necessary. Relating urinary iodine to creatinine, as has been done in the past, is cumbersome, expensive, and unnecessary. Indeed, urinary iodine/ creatinine ratios are unreliable, particularly when protein intake -and consequently creatinine excretion- is low [(7).] Supplementary Table 3 shows the epidemiological criteria for assessing the severity of IDD based on median urinary iodine levels.

Supplementary Table 3: Epidemiological criteria for assessing the severity of IDD based on median urinary iodine levels

MUIC (µg/100 mL)	Iodine status
< 2.0	Severe iodine deficiency.
2.0-4.9	Moderate iodine deficiency.
5.0-9.9	Mild iodine deficiency.
10.0-19.9	Optimal
20.0-29.9	Risk of iodine-induced hyperthyroidism within 5 or 10 years following abrupt introduction of iodized salt in susceptible groups.
>30.0	Risk of adverse health consequences (iodine-induced hyperthyroidism auto-immune thyroid disease).

4.7. Clinical Indicator (Thyroid Size, Palpation)

The size of the thyroid gland changes inversely in response to alterations in iodine intake, with a lag of 6-12 months in children and adults. The traditional method for determining thyroid is inspection and palpation. The palpation of the thyroid is important in assessing goitre prevalence. Costs are associated with mounting a survey, which is relatively easy to conduct, and training of personnel to do. For each tested student, a clinical information sheet was filled. The clinician examined each student, and the score for goitre was recorded using WHO criteria as follows Supplementary Table 4.

Supplementary Table 4: WHO classification of goitre grades.

Grade O	No palpable or visible goitre
Grade 1	A mass in the neck consistent with an enlarged thyroid is palpable but not visible when the neck is in the normal position. It moves upward as the subject swallows. Nodular alteration(s) can occur even when the thyroid is not visibly enlarged.
Grade 2	a swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated.

A clinical examination was performed solely by a well-trained general practitioner. It is recommended that a total goitre rate (TGR) (number with goitres of grades 1 and 2 divided by total examined) of 5% or more in school children 6 to 12 years of age be used to signal the presence of a public health problem [9]. Epidemiological criteria for assessing the severity of IDD based on the prevalence of goitre in schoolchildren in Supplementary Table 5.

Supplementary Table 5. Epidemiological criteria for assessing the severity of IDD based on the prevalence of goitre in schoolchildren.

Degrees of IDD expressed as a percentage of the total of the number of children surveyed			
	Mild IDD	**Moderate IDD**	**Severe IDD**
Prevalence of goitre (TGR)	5.0 – 19.9 %	20.0 – 29.9%	≥ 30.0%

4.8. Urine specimen–Analytical methods

MUIC was used to assess iodine intake. This indicator is very well-accepted, and casual urine specimens are easy to obtain. Urinary iodine assay methods were not difficult to learn or use, but meticulous attention was required to avoid contamination with iodine at all stages. Special laboratory areas, glassware, and reagents should be set aside solely for this determination.

Twenty milliliters of fresh urine were collected from each selected subject in a container and labeled with a unique identifier number corresponding to the student’s name. All samples were stored at 4 C^0 till assayed at the laboratory in Amman. MUIC was analyzed according to a standard procedure. The results were expressed as µg of iodine per 100 mL. The above procedure depended on the intensity of color formation due to the reaction of extracted urinary iodine with chloric acid with citric ammonium sulfate reduction in the presence of a ferroin indicator [9].

4.9. Special Concerns in Analysis

All necessary efforts were taken to prevent the release of toxic fumes during urine testing for iodine levels. There were no activities that dealt with infectious biological agents or blood collection and processing. The lab activities were part of routine work, and the same procedures as the ones used in the project were used on a routine basis. Disposal of medical waste associated with the performance of tests was also part of well-established disposal systems in the country. Urine collection from the survey subjects was performed only after getting written consent from their guardians.

4.10. Ethical Approval

Ethical approval for the survey protocol was issued by Ministry of Health (MOH) (IRB # MOH/SEC/2023/350). Participants and/or their guardians consented to participate before enrolment in the study. Participants assured that all data was used only for scientific purposes and for the goodness of people and that it was dealt with in full confidentiality.

4.11. Data Management and Analysis

All variables in the survey were documented. Means, median, frequency distribution, and cross-tabulation were analyzed using Statistical Package for Social Sciences (SPSS) Software and were checked entirely. Significant differences were set at a P-value of <0.05.

5. Results

5.1. Description of the Study Population and Survey Results

Table 3 shows the distribution of the study sample according to the three provinces (Figure 3) and the twelve governorates; the sample distribution provides representation at the governorate level.

Table 3: Distribution of study sample by province and governorates, Jordan, 2024.

Province/Governorate	N	%
Central	2550	47.9
Amman	1170	22.0
Balqa	440	8.3
Madaba	260	4.9
Zarqa	680	12.8
North	1790	33.6
Irbid	790	14.8
Mafraq	490	9.2
Jerash	280	5.3
Ajloun	230	4.3
South	987	18.5
Karak	327	6.1
Tafilah	190	3.6
Ma'an	220	4.1
Aqaba	250	4.7
Total	**5327**	**100.0**

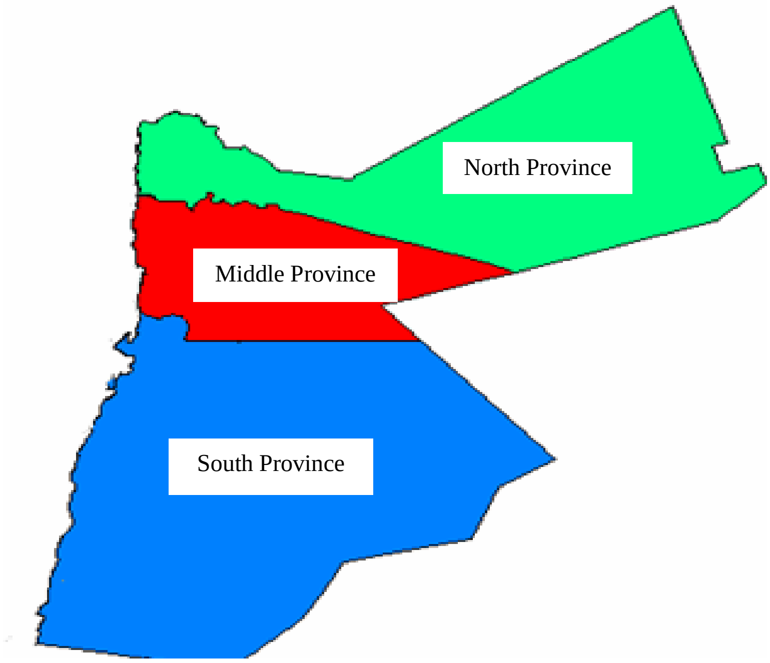

Figure 3: Jordan provinces map.

The distribution of the study sample by governorates is shown in Figure 4, while the distribution of the study sample by governorates and sex, based on the distribution of the education directorates in governorates and the type of school: public, private UNRWA and other public, as well as the sex of the school: mixed, males, or females is presented in Table 4. Males constituted 55.5% of the sample compared to about 44.5% of females (Figure 5). Additionally, Table 5 shows the distribution of the study sample by governorates and age; the proportions were almost similar.

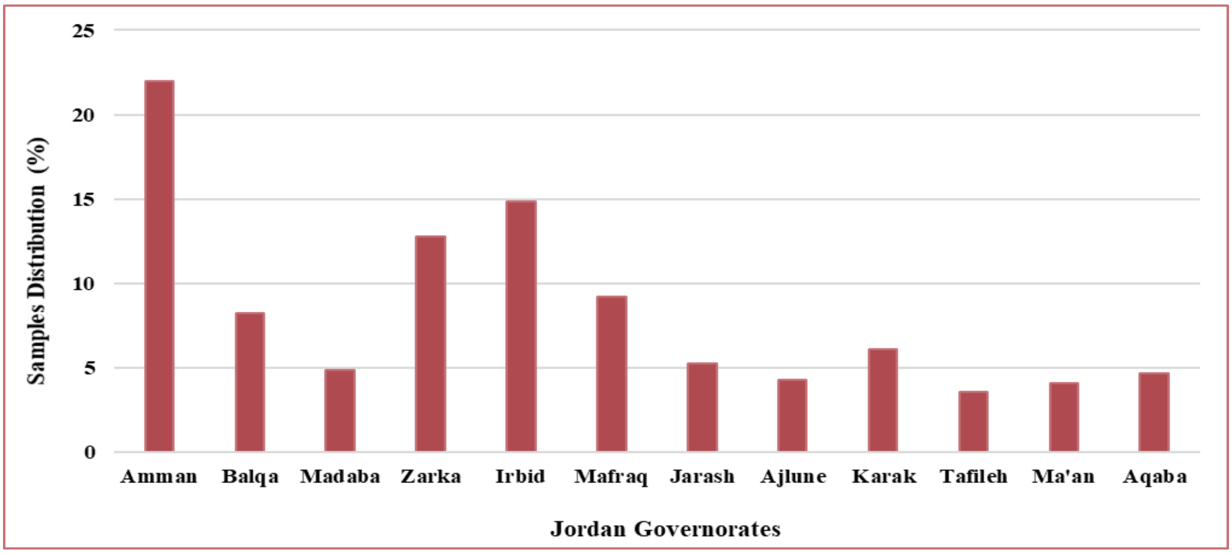

Figure 4: Distribution of study sample by governorates.

Table 4: Distribution of study sample by governorates and sex, Jordan 2024**.**

Governorate	Sex					
	Male		Female		Total	
	n	%	*n.*	%	*n*	%
Amman	672	57.4	498	42.6	1170	100
Balqa	217	49.3	223	50.7	440	100
Zarqa	400	58.8	280	41.2	680	100
Madaba	148	56.9	112	43.1	260	100
Irbid	424	53.7	366	46.3	790	100
Mafraq	264	53.9	226	46.1	490	100
Jerash	162	57.9	118	42.1	280	100
Ajloun	135	58.7	95	41.3	230	100
Karak	195	59.6	132	40.4	327	100
Tafilah	116	61.1	74	38.9	190	100
Ma'an	98	44.5	122	55.5	220	100
Aqaba	128	51.2	122	48.8	250	100
Total	**2959**	**55.5**	**2368**	**44.5**	**5327**	**100.0**

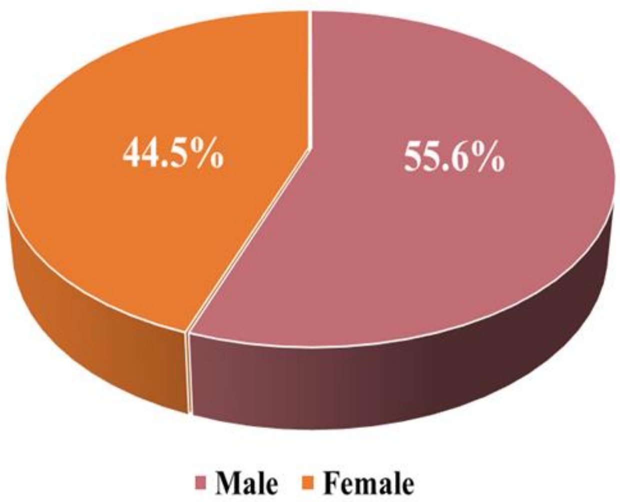

Figure 5: Percentage of participating males and females.

Table 5: Distribution of study sample by governorates and age, Jordan 2024.

Age (Years) (Grade)	8 (3rd)		9 (4th)		10 (5th)		Total	
Governorate	***n***	**%**	***n***	**%**	***N***	**%**	***n***	**%**
Amman	341	29.1	380	32.5	449	38.4	1170	100.0
Balqa	141	32.0	154	35.0	145	33.0	440	100.0
Zarqa	213	31.3	210	30.9	257	37.8	680	100.0
Madaba	72	27.7	90	34.6	98	37.7	260	100.0
Irbid	268	33.9	247	31.3	275	34.8	790	100.0
Mafraq	154	31.4	164	33.5	172	35.1	490	100.0
Jerash	89	31.8	93	33.2	98	35.0	280	100.0
Ajloun	70	30.4	81	35.2	79	34.3	230	100.0
Karak	107	32.7	119	36.4	101	30.9	327	100.0
Tafilah	70	36.8	59	31.1	61	32.1	190	100.0
Ma'an	69	31.4	66	30.0	85	38.6	220	100.0
Aqaba	71	28.4	92	36.8	87	34.8	250	100.0
Total	**1665**	**31.3%**	**1755**	**32.9%**	**1907**	**35.8%**	**5327**	**100.0**

Table 6 shows that the overall prevalence rate of goitre was 7.3% in 2024, reflecting a slight increase compared to previous years. Figure 6 illustrates the prevalence of goitre by governorate. In both sources, Ajloun stands out with the highest prevalence, significantly exceeding all other governorates. Amman, Aqaba, and Irbid display moderate levels (8–13%), which still warrant public health monitoring. In contrast, Tafileh, Madaba, Mafraq, and Jarash exhibit the lowest goitre prevalence (~3–4%), suggesting better iodine sufficiency or more effective coverage of iodized salt in those regions.

Table 6: Prevalence of goitre by governorates, Jordan 2024.

Governorate	Healthy	Goitre	Total sample size (N)	Prevalence (%)
Amman	1051	119	1170	10.2
Balqa	409	31	440	7.0
Zarqa	653	27	680	4.0
Madaba	260	0	260	0.0
Irbid	730	60	790	7.6
Mafraq	476	14	490	2.9
Jerash	271	9	280	3.2
Ajloun	173	57	230	24.8
Karak	308	19	327	5.8
Tafilah	186	4	190	2.1
Ma'an	202	18	220	8.2
Aqaba	218	32	250	12.8
Total/Average	**4937**	**390**	**5327**	**7.3**

Chi square = 190.653;
Degrees of freedom = 11
P-value = 0.0001

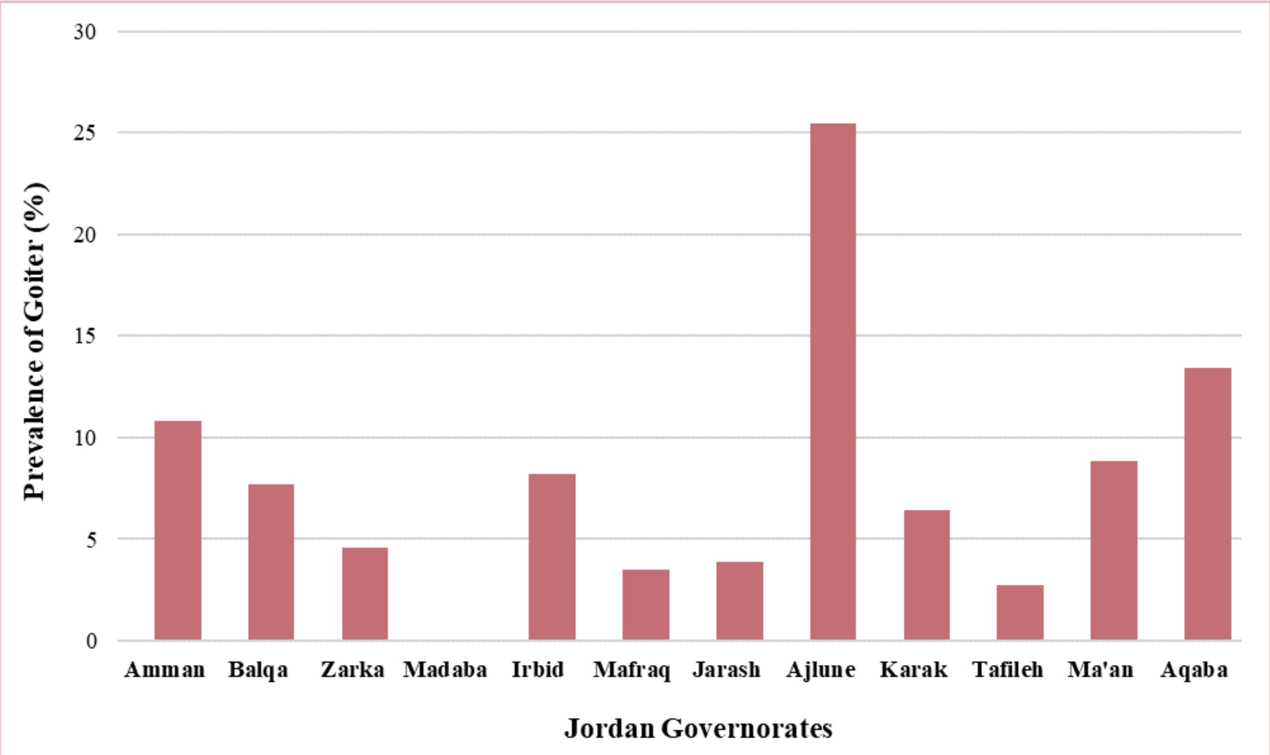

Figure 6: Prevalence of goitre by governorates.

As shown in Table 7, the prevalence of goitre is higher among females (7.8%) compared to males (6.9%). This contrasts with findings from the 2010 study, where the prevalence was higher among males (5.4%) than females (4.5%).

Table 7: Prevalence of goitre by sex, Jordan 2024

Sex	Healthy	Goitre	Total Sample Size	Prevalence %
Male	2754	205	2959	6.9
Female	2183	185	2368	7.8
Total	**4937**	**390**	**5327**	**7.3**

Chi square =1.517
Degrees of freedom = 1
P-value = 0.218

Table 8 demonstrates that goitre prevalence among Jordanian schoolchildren shows minimal variation by age, with rates of 6.7% (8-year-olds), 7.7% (9-year-olds), and 7.4% (10-year-olds). The marginally higher prevalence observed in 9-year-olds (7.7%) compared to other age groups (χ^2=1.385, df=2, p=0.50) was not statistically significant.

Table 8: Prevalence of goitre by age group, Jordan 2024

Age group (School grade)	Healthy	Goitre	Total sample size (N)	Prevalence (%)
8 years (3rd Grade)	1553	112	1665	6.7
9 years (4th Grade)	1619	136	1755	7.7
10 years (5th Grade)	1765	142	1907	7.4
Total	**4937**	**390**	**5327**	**7.3**

Chi square =1.385
Degrees of freedom = 2
P-value = 0.50

Figure A and Figure B illustrate the prevalence of goitre by sex and age group among Jordanian schoolchildren in 2024. As shown in Figure A, females exhibited a higher prevalence of goitre (7.8%) compared to males (6.8%). Figure B presents goitre prevalence by age group, showing a slight increase in prevalence with age. Children aged 9 years (4th grade) had the highest prevalence at 7.7%, followed by 10-year-olds (5th grade) at 7.4%, and 8-year-olds (3rd grade) at 6.7%.

While the differences are not large, the gradual increase may reflect cumulative iodine deficiency over time or variations in developmental needs and dietary intake. These findings highlight the need to monitor iodine status consistently across both sexes and age groups to ensure early detection and prevention of iodine deficiency disorders (IDD).

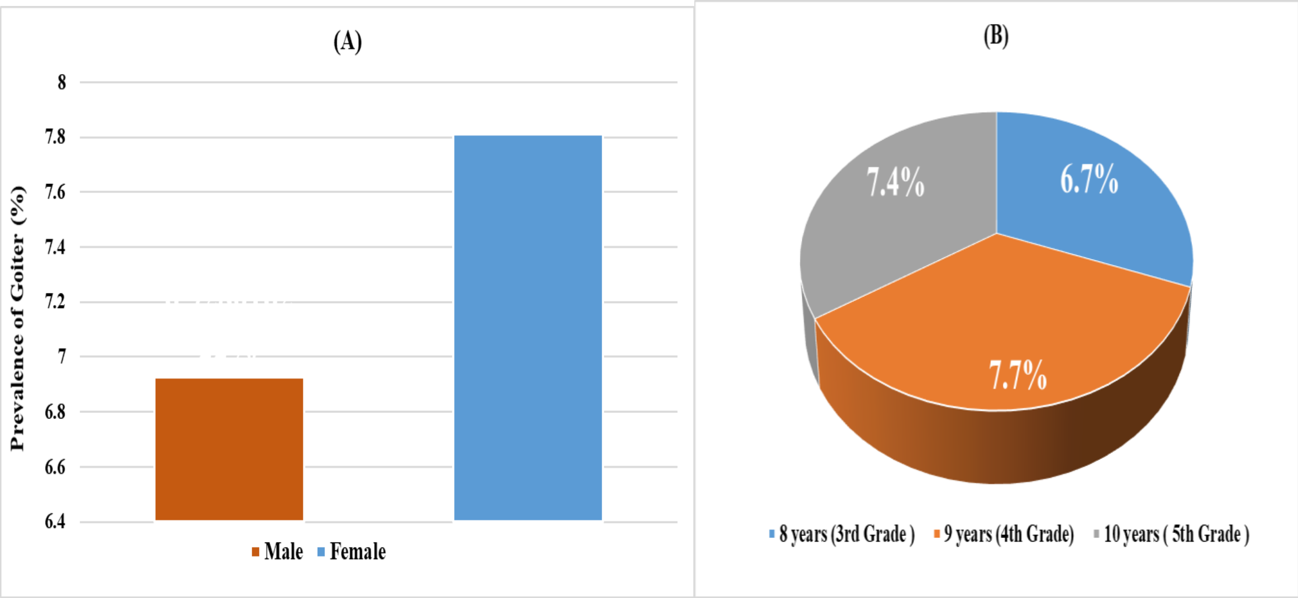

Figure 7: Prevalence of goitre by (A) sex and (B) age

Goitre prevalence across Jordan's governorates remains low overall (7.3%) but shows striking regional disparities, as detailed in Table 9. The 2024 survey found Grade 1 goitres (7.2%) account for nearly all cases, with Grade 2 presentations being exceptionally rare (0.1%). Ajloun stands out with alarmingly high rates (24.8% total prevalence: 23.9% Grade 1, 0.9% Grade 2), while Madaba achieved complete elimination (0%). This contrasts sharply with the national progress reflected in longitudinal data (1993–2024), where most regions saw dramatic declines post-iodization. Ajloun's outlier status, particularly its elevated Grade 1 prevalence despite optimal MUIC levels (14.0 µg/100mL), suggests the need to investigate non-iodine factors like diagnostic methods or environmental influences.

Table 9: Prevalence of goitre by goitre grade and governorates, Jordan 2024.

Governorate	Grade Zero		Grade One		Grade Two		Total		Prevalence (Grades One and Two)	
	n	%	n	%	n	%	n	%	n	%
Amman	1051	89.9	116	9.9	3	0.3	1170	100.0	119	10.2
Balqa	409	93.0	31	7.0	0	0.0	440	100.0	31	7
Zarqa	653	96.0	27	4.0	0	0.0	680	100.0	27	4
Madaba	260	100.0	0	0.0	0	0.0	260	100.0	0	0
Irbid	730	92.4	60	7.6	0	0.0	790	100.0	60	7.6
Mafraq	476	97.1	14	2.9	0	0.0	490	100.0	14	2.9
Jerash	271	96.8	8	2.9	1	0.4	280	100.0	9	3.2
Ajloun	173	75.2	55	23.9	2	0.9	230	100.0	57	24.8
Karak	308	94.2	19	5.8	0	0.0	327	100.0	19	5.8
Tafilah	186	97.9	4	2.1	0	0.0	190	100.0	4	2.1
Ma'an	202	91.8	17	7.7	1	0.5	220	100.0	18	8.2
Aqaba	218	87.2	32	12.8	0	0.0	250	100.0	32	12.8
Total	**4937**	**92.7**	**383**	**7.2**	**7**	**0.1**	**5327**	**100.0**	**390**	**7.3**

Table 10 describes the distribution of the MUIC (µg/100 mL) in different governorates. The overall median iodine concentration for this study was 13.0, which is considered within the optimal range (10.0-19.9 µg/100 mL) according to the WHO and ICCIDD criteria for iodine nutrition. The median iodine concentrations range from 12.0 µg/100 mL (Zarqa) to 14.0 µg/100 mL (Irbid, Jerash, Ajloun, Ma'an). The slight variations reflect differences between governorates, but all remain within the optimal threshold. (WHO classification of iodine nutritional status according to MUIC).

Table 10: MUIC (µg/ 100 mL) distribution in the different governorates based on WHO and ICCIDD epidemiological criteria for assessing iodine nutritional status, Jordan 2024.

Governorate	MUIC (µg/ 100 mL)	Iodine nutritional status
Amman	12.5	Optimal
Balqa	13.9	Optimal
Zarqa	12.0	Optimal
Madaba	12.1	Optimal
Irbid	14.0	Optimal
Mafraq	13.0	Optimal
Jerash	14.0	Optimal
Ajloun	14.0	Optimal
Karak	13.4	Optimal
Tafilah	13.8	Optimal
Ma'an	14.0	Optimal
Aqaba	13.6	Optimal
Total	**13.0**	**Optimal**

MUIC (goal: 10.0 - 19.9 µg/100 mL)

Table 11 presents the descriptive statistics of median urinary iodine concentration (MUIC) levels among schoolchildren aged 8–10 years across Jordan's governorates in 2024. Nationally, the median MUIC was 13.0 µg/100 mL, with a mean of 13.4 µg/100 mL, indicating generally adequate iodine intake according to WHO criteria (≥10 µg/100 mL). MUIC values across governorates were fairly consistent, ranging from a low median of 12.0 µg/100 mL in Zarqa to a high of 14.0 µg/100 mL in Irbid, Jerash, Ajloun, and Ma'an. The lowest individual MUIC recorded was 0.7 µg/100 mL in Amman, and the highest was 28.0 µg/100 mL in Zarqa. The standard deviation (SD) values across governorates ranged between 3.1 and 3.9, reflecting moderate variability in iodine levels. While the national iodine status appears sufficient, regional differences and the wide range of individual values emphasize the importance of continued monitoring and quality assurance in the salt iodization program.

Table 11: Median, mean, minimum, maximum, and standard deviation of MUIC (µg/ 100 mL) by governorates, Jordan 2024.

Governorate	Median	Mean	Minimum	Maximum	SD
Amman	12.5	13.2	0.7	25.0	3.3
Balqa	13.9	13.6	6.5	25.0	3.1
Zarqa	12.0	13.1	6.5	28.0	3.4
Madaba	12.1	12.8	6.5	25.0	3.1
Irbid	14.0	13.7	6.5	25.0	3.5
Mafraq	13.0	13.4	6.0	25.0	3.4
Jerash	14.0	13.8	6.8	26.6	3.6
Ajloun	14.0	14.0	6.8	25.0	3.8
Karak	13.4	13.4	6.8	22.0	3.8
Tafilah	13.8	13.9	6.8	22.0	3.9
Ma'an	14.0	13.9	6.8	22.0	3.9
Aqaba	13.6	13.6	6.8	22.0	3.9
Total	**13.0**	**13.4**	**0.7**	**28.0**	**3.5**

Iodine nutritional status and iodized salt consumption rates across Jordan's governorates in 2024 are presented in Table 12. All governorates recorded a median urinary iodine concentration (MUIC) above 10 µg/100 mL, meeting the WHO threshold for optimal iodine nutrition. Median MUIC values ranged from 12.0 µg/100 mL in Zarqa to 14.0 µg/100 mL in Irbid, Jerash, Ajloun, and Ma'an, indicating sufficient iodine intake among schoolchildren nationwide. Iodized salt coverage was consistently high, exceeding 94% in all regions. Five governorates—Madaba, Jerash, Ajloun, Karak, and Tafilah—achieved 100% coverage, while Ma'an had the lowest rate (94.1%). Despite this slight disparity, Ma'an's MUIC remained within the optimal range, suggesting that even marginally lower iodized salt access did not compromise iodine status, possibly due to contributions from other dietary sources.

Table 12: Iodine nutritional status as compared to iodized salt consumption rate by governorate, Jordan 2024.

Governorate	Median	Iodine nutritional status	Iodized salt consumption rate (%)
Amman	12.5	Optimal	99.7
Balqa	13.9	Optimal	99.8
Zarqa	12.0	Optimal	99.7
Madaba	12.1	Optimal	100
Irbid	14.0	Optimal	99.5
Mafraq	13.0	Optimal	99.2
Jerash	14.0	Optimal	100
Ajloun	14.0	Optimal	100
Karak	13.4	Optimal	100
Tafilah	13.8	Optimal	100
Ma'an	14.0	Optimal	94.1
Aqaba	13.6	Optimal	99.6
Total	**13.0**	**Optimal**	**99.5**

5.2. Comparisons over years

Table 13, along with Figures 8 and 9, illustrates a longitudinal comparison of goitre prevalence and MUIC across four national iodine surveys conducted in 1993, 2000, 2010, and 2024. The data show a substantial decrease in goitre prevalence and improvement in MUIC from 1993 to 2010 across nearly all governorates, reflecting the positive impact of Jordan’s national salt iodization program. In Irbid, for example, goitre prevalence dropped dramatically from 54.6% in 1993 to 3.6% in 2010, while MUIC increased from 2.16 µg/100 mL to 19.5 µg/100 mL over the same period. However, the 2024 data reveal a slight increase in goitre prevalence in several governorates compared to 2010, including Amman (6.7% to 10.2%), Ajloun (3.0% to 24.8%), and Aqaba (4.5% to 12.8%). Notably, Ajloun experienced a sharp and concerning rise in goitre prevalence to 24.8%, the highest among all regions in 2024. Despite continued overall improvement when compared to baseline years, the increase in goitre prevalence and the decline in MUIC in 2024 highlight the need for renewed focus on iodization program quality, regional disparities, and potential gaps in household-level iodine consumption.

Table 13: Comparison between 1993, 2000, 2010, and 2024 surveys regarding the prevalence of goitre (% of the population) and MUIC (µg/100 mL) by governorates, Jordan 2024.

Governorate	Prevalence of goitre (%)				Median urinary iodine concentration (MUIC)			
	1993	2000	2010	2024	1993	2000	2010	2024
Amman	33.7	27.8	6.7	10.2	4.84	16.3	21.5	12.5
Balqa	43.9	38.3	6.4	7.0	1.7	13.5	19.9	13.9
Zarqa	18.1	17.9	2.8	4.0	6.17	17.0	20.1	12.0
Madaba	-	-	2.4	0.0	-	-	22.5	12.1
Irbid	54.6	49.2	3.6	7.6	2.16	12.0	19.5	14.0
Mafraq	10.9	36.8	4.0	2.9	4.59	11.0	22.5	13.0
Jerash	-	-	6.7	3.2	-	-	18.9	14.0
Ajloun	-	-	3.0	24.8	-	-	18.7	14.0
Karak	22.1	48.3	3.1	5.8	6.13	18.1	18.5	13.4
Tafilah	76.1	42.4	1.6	2.1	1.58	16.9	16.7	13.8
Ma'an	65.6	27.1	5.2	8.2	1.35	23.0	16.5	14.0
Aqaba	-	-	4.5	12.8	-	-	18.4	13.6
Total	**37.7**	**33.5**	**4.9**	**7.3**	**4.0**	**15.4**	**20.3**	**13.0**

- Madaba was added to Amman
- Jerash and Ajloun were added to Irbid
- Aqaba was added to Ma'an

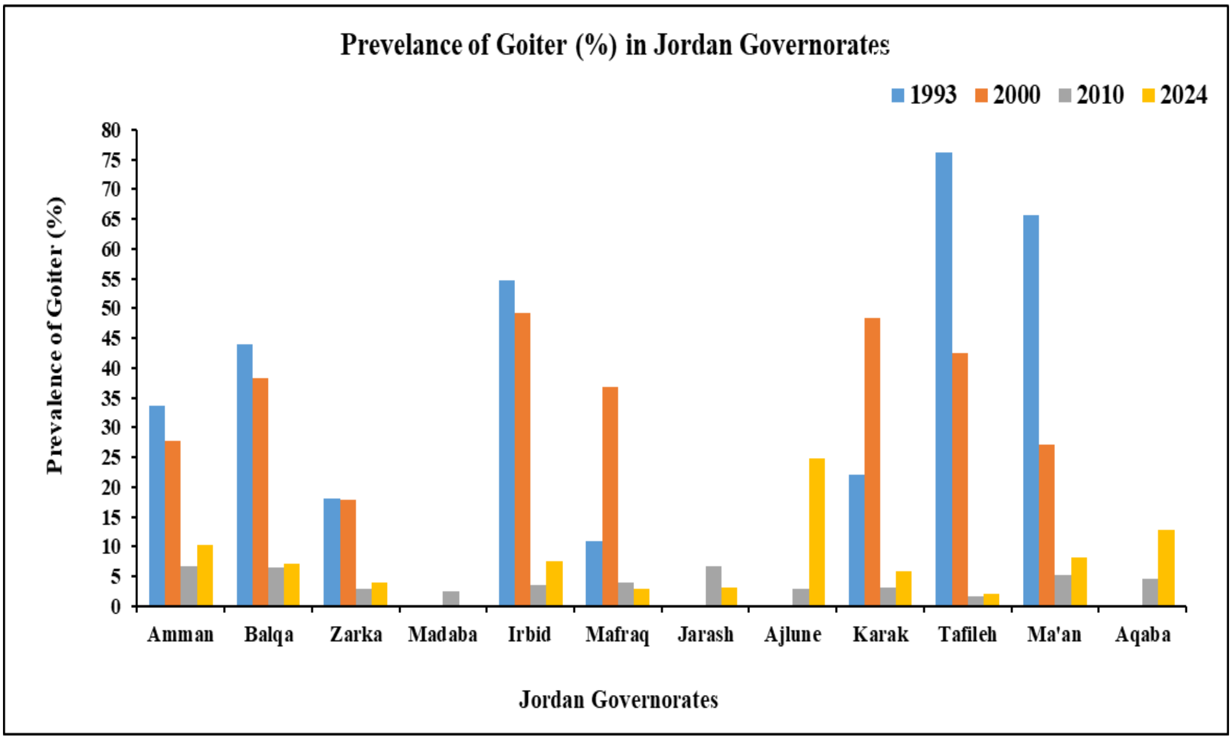

Figure 8: Prevalence of goitre by governorates (1993, 2000, 2010, and 2024).

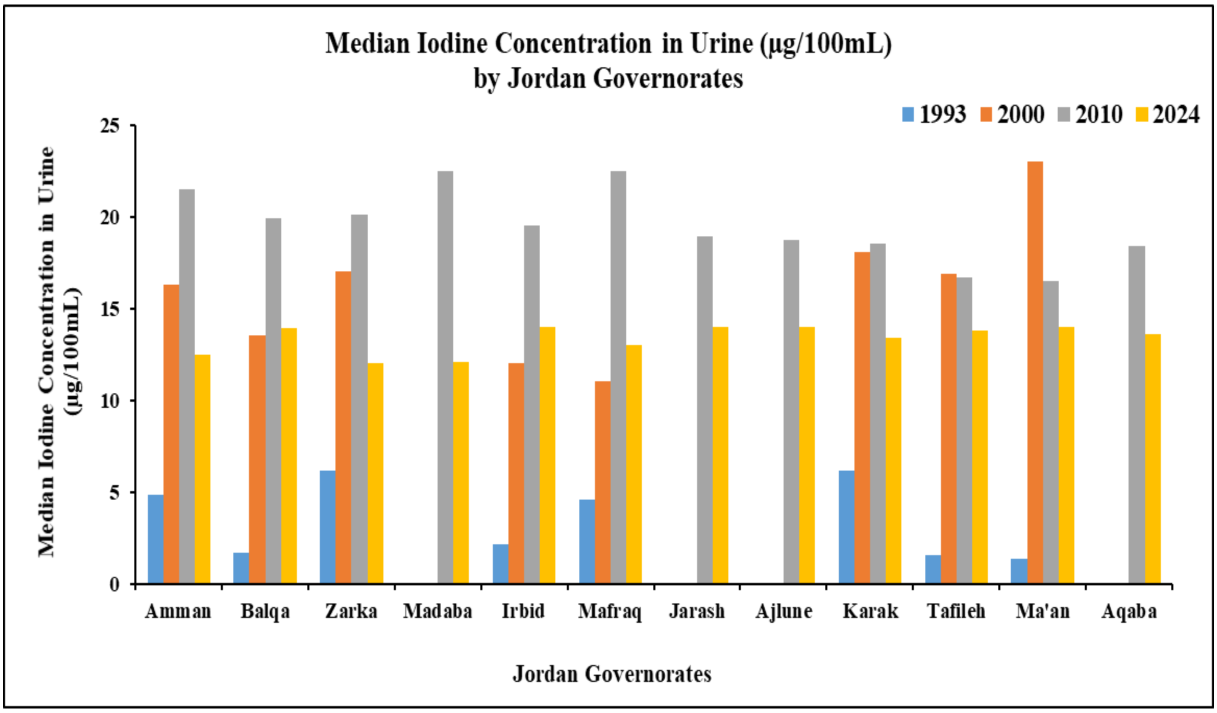

Figure 9: MUIC by governorate over four time points (1993, 2000, 2010, and 2024).

Table 14 compares the prevalence of goitre (%) and the MUIC (µg/100 mL) across Jordan's provinces (Middle, North, and South) for the years 1993, 2000, 2010, and 2024. The prevalence of goitre (%) increased across all provinces in 2024. In the Middle province, it Increased by 1.3%, from 5.6% (2010) to 6.9% (2024). Both North and South provinces experienced a 3.5% increase, with the North rising from 4.3% to 7.8% and the South rising from 3.9% to 7.4%. The MUIC declined in all provinces by 8.7 µg/100 mL in the Middle province (from 21.2 to 12.5) and by 6.4 µg/100 mL in the North province (from 20.4 to 14.0), and in the South province by 4.1 µg/100 mL (from 17.7 to 13.6).

Table 14: Comparison between 1993, 2000, 2010, and 2024 surveys regarding the prevalence of goitre (%) and MUIC (µg/100 mL) by province, Jordan 2024.

Province	**Prevalence of goitre (%)**				**MUIC (µg/100 mL)**			
	1993	**2000**	**2010**	**2024**	**1993**	**2000**	**2010**	**2024**
Middle	30.6	26.3	5.6	6.9	4.9	16.4	21.2	12.5
North	48.6	47.0	4.3	7.8	2.6	12.0	20.4	14.0
South	48.0	38.1	3.9	7.4	1.9	18.8	17.7	13.6
Total	**37.7**	**33.5**	**4.9**	**7.3**	**4.0**	**15.4**	**20.3**	**13.0**

Figures 5 and 11, respectively, show the prevalence of goitre and MUIC values by Jordan provinces over the four assessment time points (1993, 2000, 2010, and 2024). Figure 10 reveals that goitre prevalence in Jordan showed significant improvements following salt iodization efforts, though regional disparities persisted. Between 1993 and 2010, all regions experienced a dramatic decline in goitre rates, with the national average dropping from 37.7% to 4.9%. The Middle region consistently reported the lowest prevalence, while the North and South regions maintained higher rates at all-time points. By 2024, a slight increase was observed nationwide (7.3%), with the North (7.8%) and South (7.4%) remaining above the Middle region (6.9%). Notably, Ajloun (North) emerged as an outlier in 2024 with a 24.8% prevalence, suggesting localized challenges despite overall progress.

As shown in figure 11, national MUIC rose from severely deficient levels in 1993 (4.0 µg/100mL) to optimal ranges (15.4 µg/100mL in 2000 and 20.3 µg/100mL in 2010). While all regions followed this upward trend, the North and South consistently maintained slightly higher concentrations than the Middle region throughout the monitoring period. By 2024, MUIC remained within WHO's optimal range (10-19.9 µg/100mL) nationwide (13.0 µg/100mL), though levels showed a modest decline from 2010 peaks - likely reflecting the 2011 reduction in salt iodization levels from 40-60 ppm to 20-40 ppm.

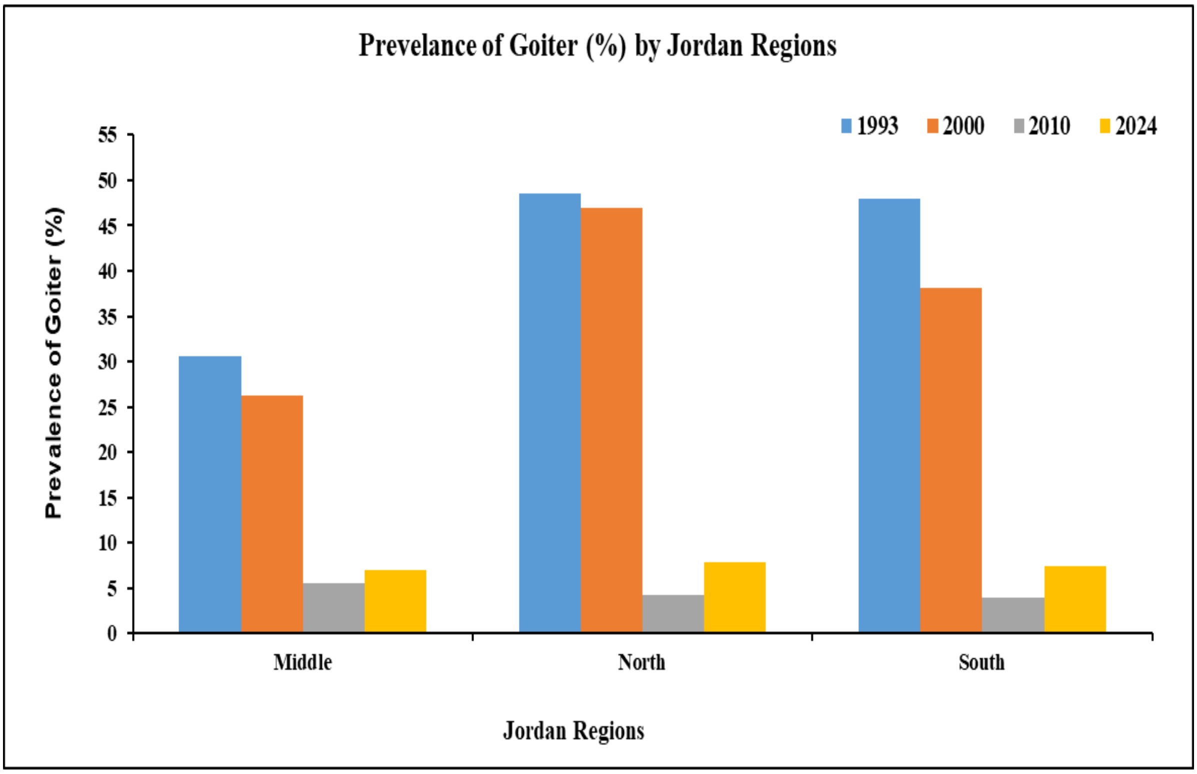

Figure 10: Prevalence of goitre by Jordan provinces (1993, 2000, 2010, and 2024)

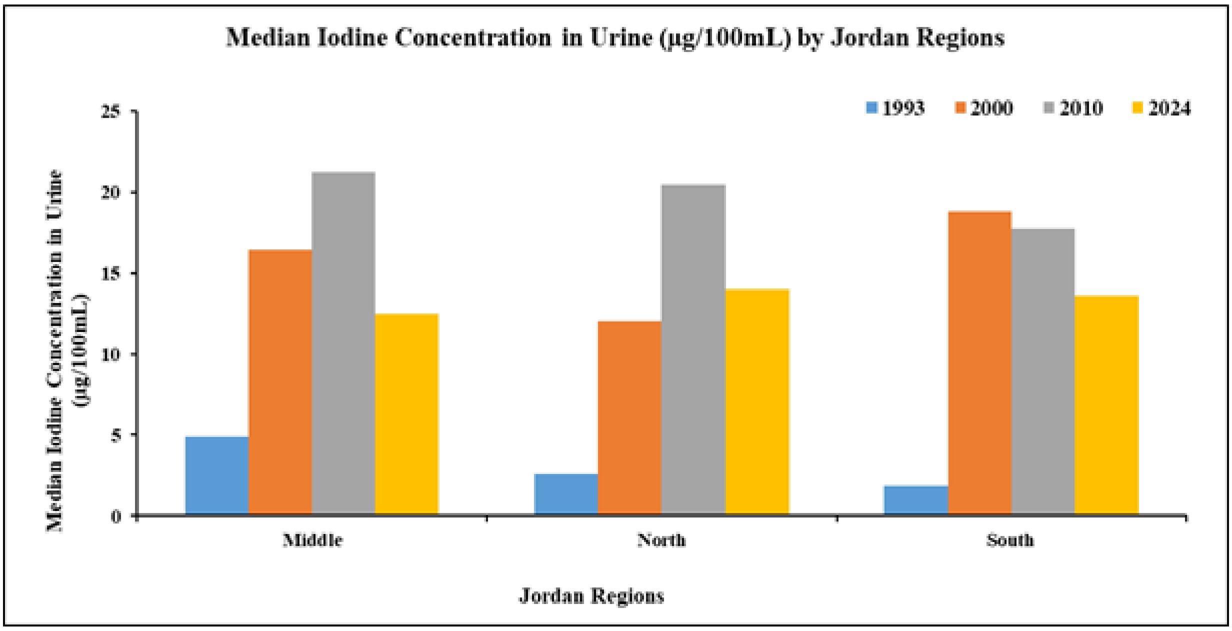

Figure 11: MUIC by Jordan provinces (1993, 2000, 2010, and 2024).

5.3. Iodized salt consumption

As shown in Table 15, 11 of 12 governorates reported ≥99.5% iodized salt consumption, meeting WHO targets (>90%). The sole exception was Ma'an (94.1%), where non-iodized salt use reached 5.9%—significantly higher than the national average (0.5%). Notably, Madaba, Jerash, Ajloun, Karak, and Tafilah maintained perfect compliance (100% iodization), while Amman, Balqa, and Zarqa showed negligible non-compliance (<0.5%).

Table 15: Prevalence and distribution of households consumed iodized and non-iodized salts by governorate, Jordan 2024.

Governorate	Iodized salt		Non-iodized salt		Total	
	n	%	n	%	n	%
Amman	1167	99.7	3	0.3	1170	100.0
Balqa	439	99.8	1	0.2	440	100.0
Zarqa	678	99.7	2	0.3	680	100.0
Madaba	260	100	0	0	260	100.0
Irbid	786	99.5	4	0.5	790	100.0
Mafraq	486	99.2	4	0.8	490	100.0
Jerash	280	100	0	0	280	100.0
Ajloun	230	100	0	0	230	100.0
Karak	327	100	0	0	327	100.0
Tafilah	190	100	0	0	190	100.0
Ma'an	207	94.1	13	5.9	220	100.0
Aqaba	249	99.6	1	0.4	250	100.0
Total	**5299**	**99.5**	**28**	**0.5**	**5327**	**100.0**

6. Conclusion

- It was evident from the findings of this survey that median iodine concentrations were optimal in all governorates. The overall median iodine concentration was 13.0 (µg/100 mL), which revealed that the study population received an adequate intake of iodine through the salt iodization program, which is considered to be optimal according to WHO/ICCIDD classification (10.0-19.9 µg/100 mL). The median iodine concentrations range from 12.0 µg/100 mL (Zarqa) to 14.0 µg/100 mL (Irbid, Jerash, Ajloun, Ma'an). The slight variations reflect differences between governorates, but all remain within the optimal threshold.
- The overall prevalence rate of goitre slightly increased to 7.3% (7.2% were grade one goitre, and only 0.1% were grade two goitre) in 2024 compared to 4.9 % in 2010. The prevalence is higher among females than males (7.8% and 6.9%, respectively). This increase may be due to the reduction in the iodine level in salt from 40.0 – 60.0 mg/kg to 20-40 mg/kg based on recommendations from the national survey 2010, as well as the specificity and sensitivity of palpation are low in grades 0 and 1 due to a high inter-observer variation so misclassification can be high.
- However, the increase in the prevalence of goitre was mainly in Ajloun since goitre prevalence increased from 3.0% in 2010 to 24.8%, the MUI C was 18.7% which is considered optimal and house hold consumption of iodized salt was 100%.
- The study showed that the iodized salt consumption rate was (99.5%) for households using salt with a content of 15 ppm up to 40 ppm compared (96.3 %) in 2010.
- In Jordan, an effective, functional implementation of WHO recommendations in the national program for iodization of salt managed by the Ministry of Health / Nutrition Policies and Programs Department includes legislation, regulations, political commitment, an effective national program committee, regular monitoring procedures, mandatory reporting, public education, and social mobilization.

7. Recommendations

- Corrective measures should be taken to ensure that iodized salt use provides adequate intake, and this is confirmed by intensive periodic monitoring in the most affected populations to ensure that iodized salt delivery systems reach all affected populations, including those in greatest need to avoid the availability of non-iodized salt from unconventional marketing sources.
- There is need for mutual education about the health and development consequences of iodine deficiency, and about the problems encountered by the salt industry in the continued production of high-quality iodized salt. Such as network and training are required in order to achieve sustainability.
- There should be mechanisms for ongoing public education about the loss of iodine due to food processing, and washing and cooking processes in the household.

- The salt industry should have the capacity to implement effective iodization, in particular with regard to compliance with the regulations and monitoring of quality assurance.
- Routine availability of population-based data on urinary iodine every five years.
- Suggestions may be discussed with a higher national nutrition committee to increase the level of iodine although the nutritional status of iodine is optimal (WHO/UNICEF/ICCIDD recommend that, in typical circumstances, iodine concentration in salt at the point of production should be within the range of 20–40 mg of iodine per kg of salt (i.e., 20–40 ppm of iodine) in order to provide 150 µg of iodine per person per day).and the prevalence of goitre is mild public health problem.

Appendix I: Activity work plan (2024)

Activity	January	February	March	April	May	June	July	August	September	October	November	December
Preparation of the study proposal			---									
Agreement of official authorities				---								
Selection of the participants and survey target group (schools)					---							
Recruitment of project staff (facilitators and coordinators)								---				
Preparation for the survey (support, material, staff, Check of all preparation. implementation of survey, data collection, and data entry)									---	---		
Data analysis and											-	-
Writing a priminerlay report												-
Dissemination of the data	In the first quarter of 2025											

Appendix II: List of the team members of the IDD 2024

Team #	Medical Doctor	Laboratory technician
1	Omar Salem	Ahmad Ayash
2	Mohammad Ibrahim	Bashar Hamoodeh
3	Mohammad Alhadidi	Ahmad Alhalaj
4	Ali Khalid	Nayef Alkhalaileh
5	Mustafa Mahmoud	Ahmad Khalaf
6	Moammar Alkhalaileh	Saif Aldeen Nassar
7	Thaher Manasrah	Ammar Dauod
8	Saif Aldeen Thaer	Younes Abu Siyam
9	Hisham Alomari	Motasem Yaser
10	Yousef Alryalat	Mosab Ramadan
11	Saleh Khalid	Mahmood Muafaq
12	Mohammad Rashaideh	Abdel Rahman Elmughrabi
13	Abdulrahman Amer	Mohammad Hussain
14	Mohammad Ghanem	Ahmad Atef
15	Mohammad Qasem	Ahmad Shehadeh
16	Hamzeh Mahmoud	Elyas Alhabashneh
17	Bilal Abusaleh	Obadah Aladaileh
18	Mustafa Mohammad	Saif Aldeen Khalid
19	Mahmood Azzam	Bayan Sulieman
20	Mohammad Rabee	Osama Zaidan
21	Mohammad Shdaifat	Tasneem Sabri
22	Ahmad Faqeeh	Aseel Shdaifat

Appendix III: Informed Consent Form

بسم الله الرحمن الرحيم

وزارة الصحة / وزارة التربية والتعليم

<u>دراسة نقص اليود وتضخم الغدة الدرقية بين طلاب المدارس</u>

السيد الفاضل ولي أمر الطالب /الطالبة ....

اسم المدرسة............................. الصف..................................

السلام عليكم ورحمة الله وبركاته،،،،،

يعتبر اليود عنصراً اساسيا لصحة الانسان ومهما للنمو خاصة في مرحلة الطفولة وحتى في مرحلة ما قبل الولادة، اذ يمكن أن يؤدي نقصه الى حالات واعراض مرضية مختلفة اهمها تضخم الغدة الدرقية، ويمكن الحد من كل هذه الاعراض والسيطرة عليها عن طريق اضافة اليود الى ملح الطعام والذي تنفذه وزارة الصحة كبرنامج وطني لتحسين الوضع الغذائي منذ عام 1995.

وضمن التقييم الدوري لبرنامج تدعيم ملح الطعام باليود، سيقوم فريق الدراسة بإجراء الدراسة الميدانية بالتعاون مع وزارة التربية والتعليم على طلبة الصفوف الثالث والرابع والخامس الاساسي في بعض مدارس المملكة بهدف تقييم نقص اليود عند طلاب المدراس حيث يتطلب اجراء المسح ما يلي:

1. قيام أطباء مختصين من وزارة الصحة بعمل فحص حسي للغدة الدرقية.
2. أخذ عينة بول من الطالب
3. إحضار عينة ملح طعام من البيت بمقدار (١٠٠) غم أي ما يعادل كأس واحد من شاي

ارجو التكرم بالموافقة على مشاركة ابنكم / ابنتكم في المسح المشار اليه أعلاه، وفي حال الموافقة يرجى التوقيع أدناه، وإعادتها مع ابنكم / ابنتكم إلى المدرسة

شاكرين لكم حسن تعاونكم

اسم ولي الأمر...........................

التوقيع....................................

التاريخ..................................

Appendix IV: Institutional Review Board Approval

وزارة الصحة

الرقم ....

التاريخ MOH/REC/2023/350

الموافق ....

قرار لجنة أخلاقيات البحث العلمي

اجتمعت لجنة اخلاقيات البحث العلمي بتاريخ 2023/9/19 لمناقشة البحث العلمي المقدم من قبل وزارة الصحة / مديرية الامراض غير السارية – قسم التغذية وبدعم مالي من الاتحاد الاوربي – المشروع الاسباني وبالتعاون مع وزارة التربية والتعليم ودائرة الاحصاءات العامة اجراء دراسة .

بعنوان :

"المسح الوطني لتقييم اضطر ابات نقص اليود لدى الاطفال الاردنيين "

وبناء عليه قررت اللجنة الموافقة على اجراء البحث العائد للجهات المذكوره اعلاه مع الالتزام بأخلاقيات البحث العلمي وتم التوقيع من قبل أعضاء اللجنة حسب الأصول.

مقرر اللجنة
وحدة تنمية الموارد البشرية
السيد/أكرم العناتي

عضو
مساعد المدير المستشفى
د.عمر العلوان

عضو
أخصائي جراحة عامة
د.جهاد البربراوي

عضو
الصيدلانية
ديانا عياد

عضو
استشاري أمراض باطنية
د.يوسف القديمات

عضو
مدير مديرية المختبرات
د.اروى النادي

عضو
أخصائي الأطفال
د.عصام الخواجا

عضو
المدير الاداري والمالي والتمريض
هاني القضاة

رئيس اللجنة
مدير ادارة مستشفيات البشير
الدكتور علي عزات العبداللات

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