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Assessment of Household Coverage of Iodized Salt and Measurement of Salt Iodine Content

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Introduction

Salt iodization is globally accepted as the primary intervention to ensure adequate iodine status among populations [7, 9, 15, 17-19]. Currently 124 countries require iodization of at least some form of edible salt [9], especially household salt, and since 1993, the number of countries considered iodine deficient has been reduced from 133 to 23 [8].

In Armenia, over the last two decades, there has been remarkable progress towards eliminating iodine deficiency disorders (IDD) and sustaining optimum iodine nutrition, largely attributed to the introduction (2004) and scale-up of the mandatory universal salt iodization (USI) strategy in the country [3, 5, 6, 10, 16]. The Iodine Nutrition Survey of 2005 showed that 97.2% of household salt in Armenia was adequately iodized and the national median urinary iodine concentration among 8-10 years old children was slightly above WHO-recommended upper limit [10, 16]. The national regulation was modified to reduce iodine content in salt from 50 ± 10 mg/kg to 40 ± 15 mg/kg. The success in attaining the goal of elimination of iodine deficiency in Armenia was acknowledged in 2006 by the Network for Sustained Elimination of Iodine Deficiency [17].

The widespread use of iodized salt was documented by the 2015 Armenia Demographic and Health Survey, which found that >99% of households in the country used salt containing >5 mg/kg iodine [12]. Another national survey

(2016-17) showed that the iodine concentration in 93,4% of household salt samples was within the national standard (mean iodine content of 35.5 mg/kg), and mUIC among school-age children was 243 μg/L, also well within the recommended range [4, 5].

The MoH had been conducting external monitoring of iodized salt on the retail and household levels. In principle, throughout 2000-2009, the IDD elimination programme in Armenia was approached as a MoH-led intervention. Its success was attributed to dedicated effort of the Multidisciplinary Working Group, responsible to the government for the national programme oversight. Avan Salt Plant, the country's single salt producer, as a strong proponent of USI in Armenia, continued supplying quality iodized salt for optimum iodine nutrition in the population.

After 2009, based on provisions of the RA Law "On Food Safety" (2006), the overall responsibility for food monitoring was assigned to the State Food Safety Service (SFSS) of the Ministry of Agriculture[1]. The National Centres for Disease Control (NCDC) continued monitoring the iodine content in salt on household level, only. The salt sampling was linked to staff visits to foci of communicable diseases (MoH Order No 405 of 1997). Throughout subsequent years, the Armenian NIH had been periodically requesting the NCDC regular monitoring data to review the National IDD elimination programme [13], as well as to develop report on assessment of the contribution of industrially processed food salt to population iodine intake in Armenia [1].

The NCDC data on monitoring of household coverage of iodized salt, for the whole 15-year period (2009 – 2023) are consolidated in the below Table 1. It is shown, that within the period of 2009-2013, only 22 salt samples (0,04% of total 53136 samples tested) did not comply with the national iodine standard; further, in 2014-2016, none of 44818 samples was non-iodized or inadequately iodized. The NCDC data were in contrast with data from parallel DHS [14], which revealed at least 102 households using non-iodized or inadequately iodized salt. The survey on iodine nutrition by N. Hutchings et al. [4, 5] also revealed certain amount (6,6%) of inadequately iodized salt samples. The NCDC detected a few more non-standard salt samples in 2017-2018, but throughout subsequent 4 years again none of samples was non-iodized or inadequately iodized and up to 2017, the overall national monitoring system did not cover salt retail and manufactured food.

[1] In July 2019, the Ministry of Agriculture was abolished; the Ministry of Economic Development and Investments was transformed into Ministry of Economy with the agricultural sector in its structure. The SFSS was transformed into **Food Safety Inspection Body (FSIB)** under Government of the Republic of Armenia.

Table 1

NCDC data on monitoring of edible salt for iodine content in households, 2009 – 2023

n/n	Year	Total number of samples (per year)	Salt samples classified as outside standard*
1.	2009	8073	10
2.	2010	6154	4
3.	2011	6107	2
4.	2012	12025	3
5.	2013	20777	3
6.	2014	14816	0
7.	2015	16449	0
8.	2016	13553	0
9.	**2017**	**7659**	**0**
10.	**2018**	**3807**	**39**
11.	**2019**	**3678**	**75**
12.	**2020**	**1132**	**0**
13.	**2021**	**1391**	**0**
14.	**2022**	**1271**	**0**
15	**2023**	**797**	**0**

* based on national standard of 25 - 55 mg/kg (data for 2017-2023 are presented for the first time).

An important milestone for Armenia's IDD elimination programme became UNICEF/IGN USI sustainability workshop for countries of Eastern Europe and Central Asia, September 24–25, 2015, Almaty [17]. Welcoming speech to the workshop was delivered by Prof. Turegeldy Sharmanov, famous public health specialist and scientist, former Minister of Health of the Kazakh SSR (1971-1982), the President of the Kazakh Academy of Nutrition (Photo 1). The workshop was attended by 50 participants from 10 countries: the participants included government officials, health nutrition experts, salt industry, in addition to UNICEF and IGN representatives (Photo 2).

In the photo (L-R): Frits van der Haar, IGN Senior Advisor; Gregory Gerasimov, IGN Regional Coordinator for Eastern Europe/Central Asia; Yuri Oksamitny, UNICEF Kazakhstan; and Prof. Turegeldy Sharmanov, president of the Kazakh Academy of Nutrition (welcome speech)[2].

In the photo: Participants of the USI Sustainability Workshop, Almaty 24-25 September 2015

[2] **Note.** In 1978, under Prof. Sharmanov's leadership, the International Conference on Primary Health Care was held in Almaty under the auspices of the WHO and UNICEF. This conference, known as the "Great Charter of Health for the 20th Century," resulted in the adoption of the Almaty Declaration, which laid out the concept of primary health care system. The conference was attended by delegations from 146 countries.

The workshop aimed to review country progress, share key experiences and lessons learnt, and develop country-specific plans to ensure sustained IDD elimination. Subsequently, in Armenia, upon the RA Prime-Minister's Instruction 02/14.7/17487-15 of 12 October 2015 and in accordance with the MoH Order 3688-A of 23 December 2015, a working group of experts from the health and agriculture sectors was established that developed "The order of the state control and implementation of monitoring over the content of iodine in food-grade salt, information exchange and public communication". This package was then adopted through the Joint Order of the MoH (No 829-A of 23.03.2016) and the Ministry of Agriculture (No 74-A of 18.03.2016). The Joint Order defines procedures for monitoring of iodine content in salt: a) imported batches, retail market, catering facilities, and processed food manufacturing entities - by SFSS, the authorized body in the area of food security (Decree No 218-N of 21.02.2013); b) in households – by NCDC, with its routine investigations of foci of communicable diseases; c) methodology for analysis of iodine content in food-grade salt, d) forms for data exchange and public communication.

Many countries primarily rely on nationally representative surveys to assess household coverage of iodized salt and iodine status of their populations. The WHO recommends to conduct national iodine surveys every 3-5 years, though the high cost and complicated logistics of such surveys are significant barriers to their implementation. A recent assessment carried out in 63 countries in Africa, South Asia, Eastern Europe and Central Asia, found that only 49% of the countries had less than 5-years old data on household coverage of iodized salt. Furthermore, only 22% of the countries had less than 5-years old data on mUIC[3]. In contrast, 51% of the countries had population level mUIC data that were more than a decade old [14].

Experience has shown that it is unrealistic to expect that there will be sufficient commitment to support costly statistically representative national surveys more frequently, to overcome the gaps in data availability. Recognizing the need for less complex and costly data collection approaches, the IGN[4] has developed an on-going programme monitoring and surveillance (M&S) methodology (called USI FORTIMAS[5]), using sentinel site data collection, that could allow for reliable analysis and interpretation of data on coverage of iodized salt [11] and mUIC among target population groups at a much lower cost, than "statistically representative" cross-sectional surveys.

The FORTIMAS approach includes secondary analysis of data on production, imports and distribution of iodized salt. Such data may be provided by domestic producers and importers and/or available through relevant

[3] mUIC - Median urinary iodine concentration (mcg/l) - indicator, used to assess iodine status of a population [19]

[4] https://ign.org/; accessed 27 March, 2024.

[5] https://www.smarterfutures.net/fortimas; accessed 27 March, 2024.

government authorities, such as the Food Control Agency, Ministry of Economy, etc. That information is then "triangulated" with findings of primary data on household coverage of adequately iodized (containing >15 mg/kg iodine [18]) and iodine status among 1st trimester pregnant women, collected using **sentinel site**[6] and purposive (non-probabilistic) data collection methods. To assess the feasibility and utility of that approach in Armenia, the IGN supported its "pilot" implementation in the country in 2023-24. Such trials of the FORTIMAS approach have also been recently supported by IGN in Sri Lanka and Tanzania. This article presents findings of secondary data on "expected" national population coverage of (any) iodized salt, and primary data on the rate of household coverage of adequately iodized salt in Armenia.

Material and Methods

The design of the non-probabilistic FORTIMAS data collection approach to assess the coverage of iodized salt and iodine status of 1st trimester pregnant women in Armenia, first included the calculation of expected annual rate of population coverage of iodized salt in the country based on the:

1) Total annual quantity of iodized salt available in the country (for use by households, commercial food catering businesses (e.g., public restaurants and canteens), and processed food production facilities (e.g., bakeries, snack food producers, etc.).
2) Estimated average per capita salt consumption of 12.5 g/day[7].
3) Annual population size of the country[8].

As illustrated in Fig. 1, data provided by the Avan Salt Plant and the Ministry of Economy, show that annual trends in the overall quantity of domestically produced and imported iodized salt has been stable in Armenia during the past decade, and decreases in domestic production have been offset by increased imports. Thus, the annual rate of expected population coverage of iodized salt has remained stable over the same time period (Fig. 2). It should be noted that the consistently higher than 100% "expected" population coverage of iodized salt in Armenia over time may in part, be due to an actual higher per capita intake of salt than 12.5 g/day, some inaccuracies in the annual quantities of iodized salt production and imports, and/or unknown amounts of the iodized salt that is not consumed during a given year.

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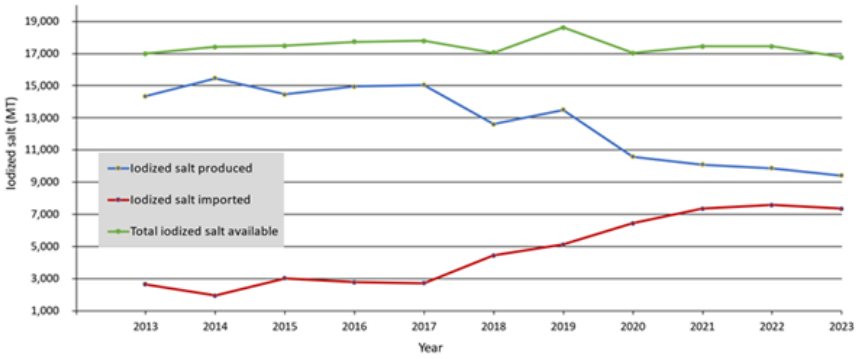
[6] "Sentinel site" refers to a community (a large town or a district) within a region, purposively selected, based on its "expected" rate of population coverage of (adequately) iodized salt, where household salt samples and urine samples of (1st trimester) pregnant women could be feasibly collected for testing to "confirm" adequate (or inadequate) rate of household coverage of adequately iodized salt and median urinary iodine concentration among pregnant women.

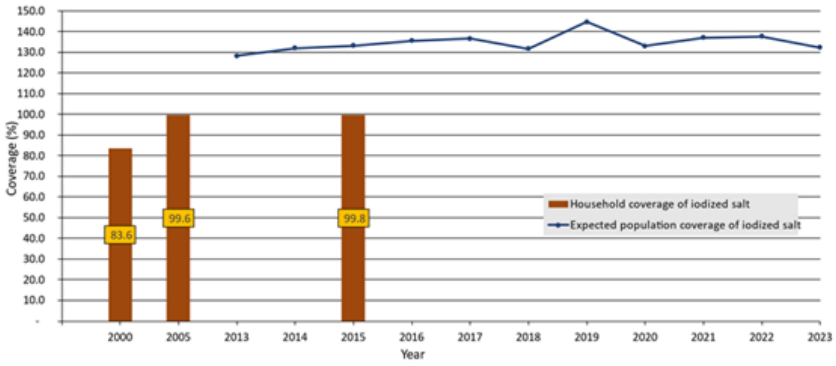
[7] https://fortificationdata.org/country-fortification-dashboard/?alpha3_code=ARM&lang=en; (Global Fortification Data Exchange (GFDx), accessed March 10, 2024

[8] Source: https://www.macrotrends.net/global-metrics/countries/ARM/armenia/population; accessed 5 March 2024.



*Based on reported data from Avan Salt Plant and Armenia Ministry of Economy, on quantities of domestically produced and imported iodized salt, respectively.

Figure 1. Trends in annual quantities of domestic vs. imported vs. total iodized* salt available in Armenia from 2013 to 2023.



*Based on data from Avan Salt Plan and Armenia Ministry of Economy on annual quantities of production and imports of iodized salt: 2013 - 2023.
**Based on findings of nationally representative Demographic and Health Surveys implemented in Armenia in 2000, 2005 and 2015 .

Figure 2. Trends in annual rates of expected population coverage* vs. assessed household coverage** of iodized salt in Armenia: 2000 through 2023.

Armenia FORTIMAS Sentinel Sites

Code	Marz	Sentinel Site
1	Yerevan	Nork district
2	Yerevan	Erebuni district
3	Yerevan	Malatia district
4	Armavir	Echmiadzin city
5	Ararat	Ararat city
6	Kotayk	Abovyan city
7	Shirak	Gyumri city

Figure 3. Marzes (Regions) in Armenia (in grey shade) where sentinel site data on household coverage of iodized salt were collected through elementary schools as "data collection points".

Household coverage of iodized salt, as a "proxy" measure of the population's overall access to, and intake of, dietary iodized salt in Armenia, has been assessed through nationally representative surveys, including three rounds of DHS, the last two of which were conducted after iodization was mandated in 2004 (Fig.2). The 2015 DHS found that that 99 to 100 percent of households in each region (or Marz) of the country used iodized salt [12].

Based on the totality of the above information, and the feasibility to fairly quickly recruit the needed number of 1st trimester pregnant women through their largest antenatal care facilities, Nor-Nork, Erebuni, and Malatia districts in Yerevan, and cities of Echmiadzin, Ararat, Abovyan and Gyumri located in Armavir, Ararat, Kotayk and Shirak regions respectively, were purposively selected as sentinel sites for primary data collection (Figure 3). Then, a secondary school (located within the catchment area of the selected antenatal care facility) was selected in each of those communities (i.e. a total of 7 schools) for data collection on household use of iodized salt.

To estimate the overall household coverage of iodized salt in the country in 2023, a total of 210 students, 30 sixth graders from each of the selected elementary schools, were recruited to bring 30 – 40 gm of table/kitchen salt from their homes (i.e. herein referred to as household salt). Each student was provided a small (5 x 7 cm) zip-lock plastic bag labelled with the predesignated identification codes of the selected school (i.e., data collection point) and student who brought the household salt sample. Upon collection of the household salt samples at the school, the relevant information was recorded in a formal reporting form, which together with the samples, were transported to the Salt Testing Laboratory of the ASP for testing of iodine content. That laboratory routinely determines iodine levels in food-grade salt, using a validated quantitative assessment tool - iodometric titration (GOST R 51575). In addition, a copy of the household salt collection form was kept at the "FORTMAS Central Office" in the National Institute of Health in Yerevan.

Results and Discussion

Each of the 210 household salt samples were tested for iodine content within 8 to 14 days of collection; about 41% of the samples were tested in less than 10 days, while the rest were tested within 10-14 days. As shown in Table 2, nearly 5.7% of the salt samples were non-iodized, and of those, 11 were from households in Shirak, while one was from a household in Yerevan (data not shown). Although the total of 30 household salt samples collected in Shirak were not enough to adequately estimate household coverage in that region, the finding that 11 of 30 salt samples collected in its largest district, is never-the-less of concern because only 1 of the 199 other salt samples from the other 6 sentinel sites was found to contain no iodine. Further assessment of iodized salt

marketed in Shirak may be warranted to better understand the reason for the unusually high rate of non-iodized salt that was found.

In contrast, only 2% of all the household salt samples from the 7 sentinel sites contained <15 mg/kg iodine, while over 92% were found to be adequately iodized (containing >15 mg/kg iodine) (Table 2). Furthermore, among the 198 salt samples found to be iodized, a mean iodine concentration of 32.8 mg/kg was within the national standard of 40 ± 15 mg/kg (data not shown).

Table 2

Ranges of iodine level in household salt in Armenia in 2023

Salt iodine level (mg/kg)	**Salt samples (N)**	**Prevalence (%)**
0.0	12	5.7
10 – 14.9	4	2.0
≥15	194	92.4
Total samples tested	210	100.0

Using the categories of edible salt falling "within" vs. "outside" the national iodization standard, as used by the FSIB for regulatory monitoring of food-grade salt in the commercial sector in Armenia, nearly 23% of the household salt samples from the sentinel sites fell "outside standard" (Table 3). Furthermore, among the "outside standard" salt samples, only 1% contained >55 mg/kg iodine, while about 17% contained <25 mg/kg iodine (data not shown). In comparison, a recent analysis of data on iodine content of salt samples collected from various market sources in Armenia and tested by the FSIB in 2023, found that the iodine content of about 31% of those salt samples fell "outside standard" [2].

Table 3

*The proportion of household salt samples with iodine content "outside standard" *, Armenia, 2023*

Salt iodine level	**Salt samples (N)**	**Prevalence (%)**
Outside standard	48	22.9
Within standard	162	77.1
Total samples tested	210	100.0

*Defined as salt with 40 +15 mg/kg iodine content.

In summary, given the findings of complementary information that indicate consistently high expected population coverage of iodized salt, and its

assessed household coverage via statistically representative surveys, during the past decade (Figures 1 and 2), our finding of about 92% household coverage of adequately iodized salt (containing >15 mg/kg iodine) in Armenia in 2023 appears to be quite reliable. The learning is particularly important because the cost of this "pilot" implementation of the FORTIMAS approach as an initial round of "annual" iodized salt program monitoring and surveillance in Armenia, was only a fraction of that of a typical nationally representative salt iodization/population iodine status survey. Furthermore, because the overall framework of a potential "Armenia FORTIMAS System" has been developed under this project, it may be estimated that about 10 annual rounds of salt iodization program monitoring and surveillance may be carried out in Armenia into the future, at about the same cost as one nationally representative salt iodization program survey.

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Оценка охвата домохозяйств йодированной солью и измерение содержания йода в соли

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Сравнительный анализ «ожидаемого» охвата населения йодированной солью (вторичные данные) и фактического охвата домохозяйств (первичные данные) показал, что ежегодный ожидаемый охват населения йодированной солью оставался стабильным в течение последнего десятилетия, при этом снижение внутреннего производства компенсировалось ростом импорта.

Только 5,7% всех проб поваренной соли, взятых в 210 домохозяйствах на 7 полевых участках, были нейодированными и только 2% содержали <15 мг/кг йода, в то время как более 92% были адекватно йодированы (>15 мг/кг йода). Средняя концентрация йода в 198 пробах соли составила 32,8 мг/кг, то есть находилась в пределах национального стандарта. Принимая во внимание полученные на основе дополнительной информации данные, согласно которым наблюдается стабильно высокий «ожидаемый» охват населения йодированной солью, а также результаты статистически репрезентативных обследований охвата домохозяйств йодированной солью, можно сделать вывод, что установление факта охвата домохозяйств адекватно йодированной солью в Армении в 2023 году на уровне 92,3% является достаточно надежным результатом.

Стоимость «пилотного» внедрения подхода FORTIMAS в качестве начального этапа «ежегодного» мониторинга и эпиднадзора за программой йодированной соли в Армении составила лишь часть стоимости общенационального репрезентативного исследования йодирования соли и статуса йодного питания населения. Поскольку в рамках этого проекта была разработана общая структура потенциальной «Системы FORTIMAS Армении», можно предположить, что в будущем в Армении можно будет проводить около 10 ежегодных раундов мониторинга и эпиднадзора за программой йодирования соли, за ту же стоимость, что и одно национально репрезентативное исследование программы йодирования соли.

Յոդացված աղով տնային տնտեսությունների ծածկույթի և աղում յոդի պարունակության գնահատումը

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Յոդացված աղով բնակչության «սպասվող» ծածկույթի (երկրորդային տվյալներ) և տնային տնտեսությունների փաստացի ընդգրկվածության (առաջնային տվյալներ) համեմատական վերլուծությունը ցույց է տվել, որ յոդացված աղով բնակչության սպասվող ծածկույթի տարեկան ցուցանիշը վերջին տասնամյակում մնացել է կայուն. ներքին արտադրության նվազումը փոխհատուցվել է ներկրման ավելացմամբ:

7 դետքային տեղամասերի 210 տնային տնտեսություններից վերցրած կերակրի աղի բոլոր նմուշների միայն 5,7%-ն է եղել չյոդացված, և միայն 2%-ն է պարունակել <15 մգ/կգ յոդ, մինչդեռ 92%-ից ավելին եղել է համարժեք յոդացված (>15 մգ/կգ յոդ): Աղի 198 նմուշներում յոդի միջին խտությունը կազմել է 32,8 մգ/կգ, այսինքն՝ գտնվել է ազգային ստանդարտի սահմաններում: Հաշվի առնելով լրացուցիչ ինֆորմացիայից ստացված տվյալները՝ համաձայն որոնց հետևողականորեն առկա է յոդացված աղով բնակչության «սպասվող» բարձր ծածկույթ, նկատի ունենալով նաև յոդացված աղով տնային տնտեսությունների ընդգրկվածության վիճակագրորեն ներկայացուցչական հետազոտությունների արդյունքները՝ կարելի է եզրակացնել, որ 2023 թվականին Հայաստանում որակյալ յոդացված աղով տնային տնտեսությունների 92,3% ընդգրկվածության բացահայտումը բավականին վստահելի արդյունք է:

ՖՈՐՏԻՄԱՍ մոտեցման «պիլոտային» իրականացման արժեքը՝ որպես Հայաստանում յոդացված աղի ծրագրի «տարեկան» մոնիթորինգի և էպիդհսկողության սկզբնական փուլ, կազմել է աղի յոդացման և բնակչության յոդային սնուցման կարգավիճակի ազգային ներկայացուցչական հետազոտության արժեքի միայն մի մասը: Քանի որ «Հայաստանի ՖՈՐՏԻՄԱՍ համակարգի» ընդհանուր շրջանակը մշակվել է այս նախագծի շրջանակներում, կարելի է կանխատեսել, որ ապագայում Հայաստանում կարող է իրականացվել աղի յոդացման ծրագրի մոնիթորինգի և էպիդհսկողության առնվազն10 տարեկան փուլ մոտավորապես նույն գնով, ինչ աղի յոդացման ծրագրի ազգային ներկայացուցչական հետազոտությունը:

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