REPORT
ON THE NATIONAL ASSESSMENT OF IODINE NUTRITION STATUS AND IODIZED SALT USE IN GEORGIA

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ON THE NATIONAL ASSESSMENT OF IODINE NUTRITION STATUS AND IODIZED SALT USE IN GEORGIA

By Dr. Gregory Gerasimov and Dr. Frits van der Haar
Iodine Global Network Consultants

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UNICEF
tbilisi@unicef.org
www.unicef.ge
http://data.unicef.ge

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ABBREVIATIONS AND DEFINITIONS

EAR	Estimated Average Requirement values for daily iodine intake
IS	Iodine in Salt (content)
IGN	Iodine Global Network
IDD	Iodine Deficiency Disorders
GNMSS	Georgia Nutrition Monitoring and Surveillance System
MOH	Ministry of Health
NCDC	National Center for Disease Control and Public Health of Georgia
KAP	Knowledge, Attitude, Practice
PW	Pregnant women
RTK	Rapid Test Kit (for testing iodine in salt)
SAC	School aged children
UIC	Urinary iodine concentration
UL	Upper Limit value for daily iodine intake
UNaC	Urinary Na (sodium) concentration
UNICEF	United Nations Children's Fund
USI	Universal salt iodization
WHO	World Health Organization

1. EXECUTIVE SUMMARY

1.1. In 2005 legislation was adopted by the Georgian Parliament mandating universal salt iodization (USI) as a public health intervention to eliminate iodine deficiency. The decision by Parliament was to ban the import and trade of non-iodized salt. The salt standard of 40±15mg iodine/kg salt was set at the same time . A follow-up national iodine survey conducted in 2005 indicated that >90% of Georgian households used adequately iodized salt. The median urinary iodine concentration (UIC) in school-aged children (SAC) was 320.7 mcg/L. It was concluded that through the effective implementation of USI legislation, Georgia met the primary WHO criteria for reaching optimum iodine nutrition of population and elimination of IDD

1.2. In 2016 a small-scale assessment of iodine nutrition in Georgia was conducted using a purposive selection and convenience sampling approach based on sentinel site data collection. Median UIC in SAC, reflective of iodine nutrition status of the general population, was 293 mcg/l (optimal levels – 100-300 mcg/l). In pregnant women (PW) median UIC was 249 mcg/l (optimal diapason – 150-250 mcg/l).

1.3. Following small-scale assessment, a representative countrywide iodine survey was conducted in Georgia in 2017. The overarching idea was to obtain nationwide information on iodine nutrition for general population (the *General stratum)* based on assessment of SAC. In the second, *Mountain stratum,* SAC were surveyed in mountain regions of Adjara and Svaneti with historically severe environmental iodine deficiency. The underlining hypothesis was that iodine deficiency may still present in these remote and hard to reach regions of the country. The countrywide sample of PW constituted the third assessment, the *PW stratum*.

1.4. The full SAC (aged 8 to 10 years) database consisted of 1219 records. The data collection consisted of a questionnaire, single spot urine sample and sample of salt from SAC household that were sent for laboratory analysis to Tbilisi labs. In the General stratum (894 records total) 67.4% of SAC resided in urban and 22.6% in rural areas. In the Mountain stratum (325 records total) most of SAC (95.3%) resided in rural areas. The database of PW consisted of 663 records obtained from antenatal clinics in all regions of Georgia, except Mtskheta – Mtianeti. The data collection among PW consisted of a questionnaire and single spot urine sample. The mean age of all PW was 27 years. On average, the PW were 2.7 months pregnant and 87.0% were in their 1st trimester of pregnancy.

1.5. Salt samples were analyzed for iodine content by titration. The total number of salt iodine (SI) data available was 1,087: 833 from the General stratum (coverage 92.6%) and 254 from the Mountain stratum (coverage 78.4%).

1.6. The mean SI content of all salt samples in the General stratum was 32.9mg/kg. None of the 833 salt samples was un-iodized; the lowest SI content was 4.8mg/kg. The SI content was below 15mg/kg in only 2.4% of salt samples and 86.4% had an SI content from 25 to 55mg/kg (Georgia national normative standard). The SI content of household salt in urban areas (33.4mg/kg) was somewhat higher ($p<0.01$) than in rural areas (31.8mg/kg). Nevertheless, the distributions of SI contents by administrative regions of the country were very similar.

1.7. All the 254 salt samples from the Mountain stratum contained some iodine, the lowest content being 2.7mg/kg. The overall mean SI content was 33.4mg/kg. The SI content was below 15mg/kg in 7.0% of samples, and 80.5% had SI content from 25 to 55mg/kg. The proportion of inadequately iodized salt in the Mountain stratum (7.0%) was higher ($p<0.05$) than in the general survey (2.4%).

1.8. The predominant type of iodized salt imported to Georgia (General stratum) is from Ukraine (63%), followed by Azerbaijan (19%) and Turkey (9%). The SI content classified by country of origin is rather homogeneous with the majority of values within requirement of Georgia standard. Although the SI content in salt from Azerbaijan was somewhat higher than the other sources, no significant difference was found in SI content by country of origin.

1.9. Results of 2017 assessment confirm excellent iodized salt coverage rate: over 90% of households in Georgia consume adequately iodized salt with SI content > 15mg/kg both in General and Mountain stratum. Quality of iodized salt was remarkably good for all major brands of salt imported from various countries.

1.10. The raw UIC data in SAC were corrected for individual variation, based on repeat urines of 192 SAC. The distribution of adjusted UIC data was less spread out than the raw spot UIC values. Adjusted UIC data were used for further data processing. Adjusted median UIC in SAC nationwide (298µg/L) was within the range (100-299µg/L) for optimum iodine nutrition of population, albeit close to the upper limit.

1.11. Median UIC findings in urban SAC were 29µg/L higher than in rural SAC (General stratum) and the median UIC of SAC in the Mountain stratum was 51µg/L lower than the median UIC in urban and rural SAC combined. Even though these are ample differences, median UIC findings in all the SAC groups are clearly above the threshold for population iodine deficiency. Percent UIC values less than 100µg/L in the 3 groups were 0.6%, 2.2% and 3.1% of SAC in urban, rural and mountainous areas, respectively.

1.12. Iodine intake of SAC was calculated, based on the adjusted UIC and body weights; the findings were compared with their age-specific Estimated Average Requirement (EAR) and the Upper Limit (UL) of recommended iodine intake. The age-specific EAR values and the UL value for daily iodine intake were compared to estimate the prevalence of inadequate (i.e., below EAR) and excessive (above UL) iodine intakes.

1.13. Of all SAC, 1.8% had iodine intake estimates below their EAR (inadequate intake) and 1.3% had iodine intake estimates above the UL (excessive intake). These findings are lower than the prevalence levels (2.3%) expected in a population with adequate iodine nutrition. The median iodine intake estimate in SAC was 227µg/day. The analysis shows that the iodine intake of Mountain SAC is lower by 43µg/day (19%) than of SAC in the General stratum. Compared to the age-specific EAR, the prevalence of deficient iodine intake in rural SAC (4.5%) and Mountain SAC (4.8%) is comparable and ±6-7 times higher than in urban SAC (0.7%).

1.14. Iodine intake findings support the overall conclusion that successful USI program led to optimal iodine nutrition of Georgia population nationwide. Only a small difference in iodine intake was found between the general population and those who reside in the mountain areas of Adjara and Svaneti that historically have been severely iodine deficient. Only a small proportion of SAC used iodine supplement (such as Jodomarine™, Jodbalance™): 0.7% in the General and 3.4% in Mountain stratum. Universally high coverage with quality iodized salt provided sustainable source of iodine in the everyday diet of the population of Georgia.

1.15. Sodium concentrations (UNaC) were obtained from the same urine samples used for UIC analysis, with the purpose to facilitate in-depth interpretation of the iodine intake findings. Similar as for UIC, the raw UNaC data were corrected for individual variation. The mean UNaC findings, which varied between 158 and 160mmol/L, did not differ across urban, rural and mountainous groups of SAC, but the UNaC findings in the mountainous Svaneti children (144mmol/L) were lower than in Adjara (164mmol/L).

1.16. The additional UNaC data permitted an in-depth analysis of the dietary sources of iodine intake, based on a regression model that considers the iodine intakes of SAC as dependent variable that can be explained by the UNaC and the SI data of the same children. The findings from this analysis showed that of the total iodine intake in SAC (211µg/day), 90µg (41%) originated from native iodine in the diet, 95µg (43%) from iodine in foods processed with iodized salt and 36µg (16%) from iodine in household salt. A separate analysis of the different SAC groups indicated the key importance of a quality-assured supply of well-iodized salt for the iodine intakes in the rural and mountainous areas.

1.17. The median UIC in the 634 PW was 211µg/L. This finding suggests optimal iodine status of PW in Georgia as the level is conveniently in the middle of the normative 150-250µg/L range. The median UIC of the

541 PW who were in the 1st trimester of pregnancy was 211µg/L, which is very similar as for the findings among all the PW. The median UIC in rural PW was 226µg/L and 205µg/L in urban PW. Among the women in their 1st trimester of pregnancy, the median UIC findings were 223µg/L in the rural and 207µg/L in the urban PW. Given the high dispersion of UIC values which is typical for spot urine collections, these differences are minor.

1.18. About one-third of PW reported the use of iodine supplements in the past (25.9% of all PW) or at present (6.8% of all PW). The median UIC in PW who reported having used iodine supplements in the past was 209µg/L; in PW who stated the use of supplements at the time of urine sampling, the median UIC was 227µg/L and among those who reported never having used a supplement, the median UIC was 211µg/L. The finding of higher UIC values among the supplement users is not surprising. However, the typical dispersion of UIC values in spot urine samples does not permit an interpretation based on statistical testing of these differences.

CONCLUSIONS AND RECOMMENDATIONS

1.19. The results of the 2017 assessments confirmed that Georgia has a sustained, effective USI program with more than 90% coverage of the population with quality iodized salt imported from several countries. Optimal iodine nutrition status has been achieved and sustained for the general population (based on assessments of SAC) and PW. Further monitoring of iodized salt use and iodine nutrition is recommended to assure permanent IDD elimination and optimal iodine nutrition in Georgia.

1.20. While median UIC in SAC countrywide is close to upper limit, there is no urgent need to alter or reduce current normative levels of salt iodization (40±15mg/kg). Analysis of iodine intakes in SAC showed no evidence of excess iodine consumption in any group (urban, rural, mountain). Moreover, iodine nutrition in PW is perfectly normal with median UIC (211µg/L) conveniently in the middle of recommended values.

1.21. Median SI levels collected from households in all cohorts were very close (in the range of 32-34mg/kg) and perfectly within requirements of Georgia salt standard. Potential decrease of salt iodization normative values even by 10mg/kg (25%) can results in suboptimal iodine intake in some groups of PW and, potentially, in mountain SAC where median UIC was 51µg/L lower than in SAC from the General Stratum. Such move can potentially put at risk entire salt iodization strategy in the country and erode optimal iodine nutrition of entire population.

1.22. Monitoring of iodine nutrition of population, coverage and quality of iodized salt should be continued and strengthened. Currently Georgia has excellent laboratory capacity for performing quality assured analysis of iodine in urine. GNMSS (Georgia Nutrition Monitoring and Surveillance System) should continue to monitor iodine nutrition (as well as status of other micronutrients) on annual basis. A test run of iodine assessment in the framework of GNMSS in 2016 showed that median UIC in 91 SAC (293 µg/L) was practically the same as in 847 SAC assessed during 2017 survey (298 µg/L). Median UIC in 47 PW assessed in 2016 was 249µg/L, only slightly higher than in 643 PW in 2017 - 211µg/L. Because of universal coverage of population with quality iodized salt, GNMSS can provide extremely accurate estimation of iodine nutrition at a small fraction of costs of the national iodine survey.

1.23. Health professionals (endocrinologists, OBG, pediatricians, general practitioner, etc.) should be discouraged to recommend iodine supplement to PW and SAC without strong suspicion of inadequate iodine intake (such as veganism or extremely low salt consumption for medical or behavioral reasons). Already only relatively small number of PW (6.8%) and insignificant (from 0.7% to 3.4%) proportion of SAC used iodine supplements at the time of the assessment.

1.24. Results of 2017 Georgia iodine survey should be published in national and international medical journals and presented on the meetings. Balanced and scientifically correct information should be provided to general public through the media.

2. INTRODUCTION

Iodine deficiency has affected humans for thousands of years. It has been identified as a global public health problem and as the main cause of preventable mental retardation, with over a billion people at risk worldwide.

The most cost-effective and sustainable intervention to eliminate IDD is the iodization of all edible salt, with the target of more than 90% of households consuming adequately iodized salt. Once a program has advanced to a stage where a significant proportion of all edible salt being produced or imported is iodized, it will be appropriate to assess household coverage for the country as a whole.

The objective of all USI/IDD monitoring and surveillance activities is to ensure that the program is proceeding smoothly, but also to identify problems where necessary, set priorities and take corrective action. Targets and goals of IDD elimination program are presented in Table 1.

Table 1. Targets and Goals of Elimination of Iodine Deficiency Programs[1]

Process:	
1.	All edible salt produced and imported, is iodized
2.	90% of households are using <u>adequately</u> iodized salt (≥ 15 mg/kg)
Impact:	
1.	Less than 20% of population has UIC below 50 µg/L
2.	Median UIC in the population is between 100 and 299µg/L

The median UIC cut-off proposed for classifying iodine nutrition into different degrees of public health significance is shown in Table 2.

Table 2. Epidemiologic criteria for assessing iodine nutrition based on median urinary iodine concentrations in school children [1, 2]

Median UIC (µg/L)	Iodine intake	Iodine nutrition
< 20	Insufficient	Severe iodine deficiency
20-49	Insufficient	Moderate iodine deficiency
50-99	Insufficient	Mild iodine deficiency
100-299	Adequate	Optimal
> 300	Excessive iodine intake	Risk of iodine-induced hyperthyroidism within 5-10 years following introduction of iodized salt in susceptible groups

1 Adapted from: Guidelines for Monitoring of Salt Iodization programs and tracking progress towards elimination of iodine deficiency in East Asia and Pacific. By J. Gorstein and K. Codling, UNICEF, 2005

After collapse of the Soviet system of endemic goiter prevention in 1991, legislation was passed in 2005 in Georgia mandating the iodization of all salt for human (and animal) consumption as a public health intervention to eliminate iodine deficiency in the country. In the November 2005, a national survey indicated that >90% of Georgian households used adequately iodized salt. Out of 957 salt samples tested with rapid test RTK, 867 (90.6%) were adequately iodized (> 15 ppm), and only 39 (4.1%) had no iodine. Iodization of salt was validated in 136 random samples using iodometric titration: 94.1% were adequately iodized. The median urinary iodine concentration (UIC) in school-aged children (SAC) was 320.7μg/L, and only 4.4% of urinary samples were below 100μg/L. It was concluded that due to effective implementation of USI legislation, Georgia met the primary WHO criteria for IDD elimination [3].

However, subsequent survey conducted in Kvemo-Kartli Region in 2008 found a median UIC of 90μg/L among SAC, with about 71% of them having UIC <100 μg/L. Furthermore, a national nutrition survey, also carried out in 2008, found that about 52% of women of childbearing age had UIE <100 μg/L, and the median UIE among that population group was 99 μg/L; this was lower than the range of 100 – 299 μg/L which signifies a population as non-iodine deficient [4]. The discrepancy in UIC between the 2005 and subsequent surveys could be explained by insufficient quality of urinary iodine assays in the assigned Georgia labs that lacked internal and external quality control systems.

The last published data related to salt iodization came from the national nutrition survey conducted in 2009, which found that essentially all households in Georgia used iodized salt which met the national standard for iodine content.

The 2016 data indicated that 28,600 MT of iodized salt for human consumption was imported to Georgia annually. This amount is more than sufficient to meet the per capita needs of the population. Approximately 60% of the salt is imported from Ukraine, while about 25% and 6% of the product is imported from Iran and Azerbaijan, respectively. The remaining small proportion of salt comes from Greece, Egypt, Russia and Turkey [4].

Starting from 2015, Iodine Global Network (IGN) established an alliance with Georgian National Centers for Disease Control and Public Health (NCDC), a government public health agency, UNICEF and professional groups of endocrinologists to strengthen iodine monitoring and update information on current status of iodine nutrition.

Working closely with NCDC, IGN provided resources for launching UIC analysis in "Test Diagnostika" laboratory in Tbilisi and linked in with the Regional Iodine Reference laboratory in Almaty (QUICK Network) and CDC. This was important contribution to strengthening monitoring and surveillance of the national USI program in Georgia that has been highly acknowledged by Director of NCDC Dr. A. Gamkrelidze.

Following request from NCDC, IGN supported assessment of iodine nutrition in Georgia within the NCDC-led "Georgia Nutrition Monitoring and Surveillance System" (GNMSS) project funded by the US CDC using a purposive selection and convenience sampling approach based on sentinel site data collection. The primary aim of the GNMSS is to systematically track trends, over time, in the quality, coverage and impact of large-scale nutrition interventions, such as USI [4].

During May-August 2016, 91 urine samples were collected from SAC and 47 samples from PW in the 3 sentinel regions (Tbilisi, Batumi and Lagodekhi). Median UIC in SAC, reflective of iodine nutrition status of the general population, was 293μg/L (optimal levels – 100-300μg/L). In PW median UIC was 249μg/L (optimal diapason – 150-250μg/L). Median UIC in SAC were lower in 2016 assessment (293μg/L) than in 2005 survey (320,7μg/L). All samples of salt (except one) collected in Batumi and Lagodekhi stained positively for iodine when tested with RTK.

Thus, results of the 2016 small-scale assessment indicated optimum iodine nutrition of Georgian population. At the same time, median UIC in SAC and PW were very close to upper normal range. This prompted NCDC and UNICEF to conduct the national survey of iodized salt use and status of iodine nutrition in Georgia.

The main goals of the survey were to:

1) Provide information on coverage of population with iodized salt in Georgia nationwide (with focus on remote mountain areas of Adjara and Svaneti), and on adequacy of iodine content in salt on the household level though quantitative measurement of iodine concentration in salt,

2) Determine status of iodine nutrition of the population in Georgia nationwide (with focus on remote mountain areas of Adjara and Svaneti) by measuring UIC and total body weight in SAC,

3) Assess status of iodine nutrition in PW by collecting urine samples on the 1st trimester of pregnancy in clinics nationwide and measuring UIC,

4) Conduct questionnaire study to assess knowledge, attitude and practice (KAP) of population (parents of SAC, PW) towards iodized salt, as well as use of iodine nutritional supplements.

5) Assess the relationship between salt consumption and iodine status among the Georgia population and conduct statistical analysis to obtain estimates for the key dietary iodine intake sources (native iodine in the common diet, iodine from household salt, and iodine from consuming food manufactured with iodized salt). In order to do this, the urinary sodium concentration in SAC will be measure as well as a repeat urine sample from a selection of ± 150-200 SAC collected.

6) Allow for comparison with previous and future iodine surveys,

7) Develop recommendations for revision of present normative values of iodine in salt, as well approaches to use of iodine nutritional supplements among SAC and PW.

3. METHODOLOGY

Sampling design for the National iodine nutrition survey in Georgia has been developed by Mr. Mamuka Nadareishvili, UNICEF consultant. Sections 3.1. and 3.2. of this chapter are based on his Report [5] abbreviated and edited for this document.

3.1. Survey participants and sampling issues

During the preparation phase for the national survey, the NCDC technical team suggested to conduct in fact three independent surveys and thus create three samples:

- Countrywide sample of SAC of III-IV form;
- Sample of III-V form SAC from mountain regions
- Countrywide sample of PW;

The overarching idea was to obtain nationwide information on iodine nutrition for general population in Georgia (based UIC from SAC) – the *General stratum*. SAC residing in mountain regions (Adjara and Svaneti) with historically high severity of iodine deficiency constituted the *Mountain stratum*. The underlining hypothesis was that iodine deficiency may still present in these hard to reach regions of the country. Since iodine deficiency has detrimental effect on brain development in fetus, the countrywide sample of PW constituted the third, the *PW stratum*.

According to Ministry of Education (MOE) data, there are approximately 133,000 students in III-V forms in Georgia. Design effect of the survey was set to 2.5. With this assumption, in order not to have error more than 5% with 95% confidence, 900 interviews should be conducted in the General Stratum. In order to achieve the same precision level for the Mountain stratum (Svaneti and mountainous Adjara) where around 2,000 SAC are residing, approximately 320 SACs should be assessed.

Antenatal care centers are attended by around 50,000 PW annually. In order to obtain estimates with the necessary precision (error of no more than 5% with 95% confidence), approximately 600 PW should be assessed during the survey.

3.2. Selection of schools and schoolchildren

Two-stage cluster sampling was used for the survey. A school was considered as a cluster. Design effect highly depends on the number of interviews in each cluster. In previous surveys in Georgia 30 SAC 8-10 years of age were assessed in each cluster. If the number of students is decreased from 30 to 15, design effect will decrease by 30-40% and the effective sample size will increase by the same percentage. This will result in the decrease of the errors of estimates. So, it was decided to assess 15 SAC in each selected cluster (school).

Children of 8-10 years of age usually attend III, IV or V form. According to Ministry of Education (MOE), there are 132,746 students in III-V forms of 2,242 schools that are located in 11 administrative regions of Georgia.

The survey was conducted in every region of Georgia, which were sub-divided into urban/rural cohorts. As Tbilisi had only urban cohorts, the General stratum was divided into 21 cohorts.

A school was the primary sampling unit (cluster). In every selected school in urban cohorts 15 SAC should be assessed. The number of SAC is small in schools in rural cohorts: 94% of such schools have less than 15 SAC. For this reason, only 9 SAC should be assessed in every selected school in rural cohorts. The exception is rural cohort of Racha-Letchkhumi-Kvemo Svaneti Regions, where the number of students was the smallest. In each selected school in these regions only 6 students will be assessed. The suggested distribution of clusters/SAC between the regions and urban/rural cohorts is presented in Table 3. Clusters were selected using PPS (Probability Proportional to Size) method.

Table 3. Distribution of clusters/SAC by regions and urban/rural cohorts in the General stratum [5]

Regions	Number of clusters			Number of interviews		
	Urban	Rural	Total	Urban	Rural	Total
Tbilisi	18		**18**	270		**270**
Shida Kartli	2	3	**5**	30	27	**57**
Kvemo Kartli	3	5	**8**	45	45	**90**
Kakheti	2	4	**6**	30	36	**66**
Samtskhe-Javakheti	2	2	**4**	30	18	**48**
Adjara	3	3	**6**	45	27	**72**
Guria	2	2	**4**	30	18	**48**
Samegrelo-Zemo Svaneti	2	3	**5**	30	27	**57**
Imereti	5	3	**8**	75	27	**102**
Mtskheta-Mtianeti	2	2	**4**	30	18	**48**
Racha-Leckhumi-Kvemo Svaneti	2	2	**4**	30	12	**42**
Total	43	29	**72**	645	255	**900**

Regions with historic severe iodine deficiency (Svaneti and mountainous Adjara) constituted separate Mountain stratum. There are 157 schools in these regions with 2,027 students in III-V forms. In 40% of schools there are less than 9 SAC in III-V forms. SAC from these small schools were combined with a SAC from another school in the neighboring village into the same cluster. Thus, in each cluster the number of assessed SAC will be 9 or more. In order to achieve the desired precision, 324 SAC should be assessed in 36 clusters (42 schools).

Repeated collection of urine samples was planned from 2 SAC in each selected clusters of the General and Mountain strata. These SAC will be preselected during initial assessment and repeated urine sample collected 24 after initial one. In total, repeated urine samples should be collected from 144 SAC in General stratum and 72 SAC in the mountain stratum.

3.3. Selection of pregnant women

On average, every month 4,068 PW in their 1st trimester visit antenatal health centers in Georgia, or approximately – 185 PW per day. These visits are free of charge and include examination by the obstetrician and collection of blood and urine samples for laboratory analysis. In fact, the additional task of the doctor or nurse is to conduct interview and complete special survey questionnaire. Also a small volume of urine (about 1 ml) should be aliquoted in a separate vial, labeled and shipped to laboratory in Tbilisi for iodine analysis.

In order to survey 600 PW within one week, all antenatal health centers in the country will be contacted to recruit PW into the assessment. The only exclusion criterion is for PW taking iodine supplements.

3.4. Salt and urine specimen collection. Laboratory determination of iodine in salt and iodine and sodium urine.

Procedures for salt and urine specimen collection are listed in **ANNEX 1**. Collection of all samples in each cluster (school) was conducted by field staff of National Center for Disease Control and Public Health of Georgia in the period of May – June, 2017. In pregnant women only urine samples were collected by staff of regional antenatal health centers and shipped to laboratories in Tbilisi.

UIC were assayed in the "Test Diagnostics Ltd" laboratory (Address - 61 Tsintsadze str, Tbilisi 0060, Republic of Georgia) under supervision of Dr. Nelly Barnabishvili. Iodide is the catalyst in the reduction of ceric ammonium sulfate (yellow) to the cerous form (colorless), and is detected by the rate of color disappearance (Sandell-Kolthoff reaction). The procedure for determining iodine in urine after ammonium persulfate digestion with spectrophotometric detection, as well as results of internal and external quality control are presented in **ANNEX 2**. UIC is expressed in µg/L (micrograms per liter).

Sodium (Na) content in urine was assayed by ion-selective electrode method. Collected urine samples were processed in LTD "Mrcheveli" - European Limbach diagnostic Group (Tbilisi) and shipped to LTD "Labor Dr. Limbach and Kollegen" (Heidelberg, Germany) for the analysis. Internal quality control was performed every 24 hours, following each calibration and in necessary cases. Reference sodium content in random urine is 64-172 mmol/l. Certificate for external quality assessment of this laboratory is on the file.

Salt iodine (SI) content was measured by iodometic titration method in accrodance with GOST R 51575-2000 "Nutritional iodized salt. Methods of analysis of iodine and sodium tiosulphate"[2] in Testing Laboratory "TestLAB" of the Agricultural University of Georgia in Tbilisi. SI content is expressed in mg/kg (milligrams in kg). Internal quality control procedures to monitor convergence, reproducibility and accuracy of the results were carried out according to Appendix B to the above GOST.

3.5. Data entry and statistical analysis

Information from survey forms, questionnaires and laboratory results (for UIC, UNaC and IS content) was entered into the database by a database administrator in the National Center for Disease Control and Public Health in Tbilisi, Georgia.

Calculations were performed in Microsoft Excel with Analyse-It plug-in software (https://analyse-it.com/). The data processing was based on standard epidemiological procedures (e.g., Altman DG et al, Statistics with Confidence 2nd Edition, BMJ Books, 2000; and Bland M, Introduction to Medical Statistics 4th Edition, Oxford University Press , 2015) and verified, when possible, by duplicate analyses using web-based software (e.g., Web Epi and Win-PEPI). The UIC and UNaC values in SAC were adjusted to account for intra-individual variation with use of the method proposed by the Institute of Medicine [6]. Adjusted UIC and UNaC values were used for reporting of findings. Multiple linear regression analysis was performed on non-weighted data. Because the frequency distributions of UIC values in SAC and in PW were skewed, natural logarithmic transformation was used for multiple regression and statistical testing of differences between groups and across regions. For Student's t-testing, two-sided P values <0.05 were considered significant. Fisher's F values (from analysis of variance) are reported to illustrate the comparative strength of associations between indicators.

2 http://gostexpert.ru/data/files/51575-2000/e7d5cd721eadd8486a06d4a04c478e5e.pdf

4. RESULTS

4.1. Studied population

The survey was conducted in May-June 2017 and covered in total 1219 SAC of both sexes (aged 8 to 10 years) who were educated in third to fifths forms in schools in all administrative regions of Georgia. SAC assessment was subdivided into two Strata – General (countrywide) and Mountain (mountain parts of Adjara and Svaneti region). Countrywide sample of PW consisted of 663 records obtained from antenatal clinics in all regions of Georgia, except Mtskheta – Mtianeti.

4.1.2. SAC Database description

The full SAC database consisted of 1219 records from all regions included in the General and the Mountain strata. The data collection consisted of a questionnaire (**ANNEX 3**) that was completed by parents or legal guardians of SAC, single spot urine sample and sample of salt from SAC household that were sent for laboratory analysis to Tbilisi labs.

According to questionnaire responses, in the General stratum (894 records total) 67.4% SAC resided in urban and 22.6% in rural areas. In the Mountain stratum (325 records total) most of SAC (95.3%) resided in rural and only 4.7%in urban areas.

In the General Stratum UIC data were available of 847 SAC (94.7% completion rate) from all regions. SI content data were available of 833 SAC (93.2% completion rate): 569 SAC from urban and 264 - from rural areas. In the Mountain stratum UIC data were available for 299 SAC (92% completion rate).

SI content data were available for 833 SAC in the General stratum (93.2% completion rate) and 254 SAC in the Mountain stratum (78.1% completion rate).

4.1.2. PW Database description

During one week in June 2017, PW were enrolled in antenatal clinics of Georgia at the time of their regular clinical attendance. The data collection consisted of a questionnaire (**ANNEX 3**) and a single spot urine sample, which was sent to the Tbilisi laboratory for iodine analysis (UIC).

The full database consisted of 663 PW records from 165 clinics in 10 regions (Table 4). No data were received from Mtskheta - Mtianeti region: because of its proximity to Tbilisi, most PW prefer to visit antenatal clinics in the capital city. UIC data were available of 634 PW (95.6% completion rate) from 161 clinics. The average yield was 3.84 UIC data per clinic, varying between 1.67 in Racha – Lechkhumi and Kvemo Svaneti region to 5.23 in Samegrelo, and Zemo Svaneti.

The mean age of all PW was 27 years (SD 6.0). On average, the PW were 2.7 months pregnant (SD 1.2) and 87.0% (n=554) were in their 1st trimester of pregnancy.

Table 4. Description of PW database

Region code	No of clinics	No of PW records	Percent	No of PW records with UIC data	Percent	No of UIC data per clinic
1- Adjara	10	23	3.5	23	3.6	2.30
2 - Tbilisi	53	229	34.5	210	33.1	3.96
3 – Kakheti	12	37	5.6	35	5.5	2.92
4 - Imereti	21	101	15.2	98	15.5	4.67
5 – Samegrelo and Zemo Svaneti	22	116	17.5	115	18.1	5.23
6 – Shida Kartli	11	45	6.8	43	6.8	3.91
7 – Kvemo Kartli	18	45	6.8	43	6.8	2.39
8 – Guria	6	16	2.4	16	2.5	2.67
9 – Samtskhe-Javakheti	9	46	6.9	46	7.3	5.11
11 – Racha –Lechkhumi and Kvemo-Svaneti	3	5	0.8	5	0.8	1.67
Georgia	165	663	100	634	100	3.84

4.2. National and regional usage of iodized salt

Salt samples brought to school from the households of SAC were analyzed for salt iodine (SI) content by titration. The total number of SI data available was 1,087; 833 from the General stratum (coverage 92.6%) and 254 from the Mountain stratum (coverage 78.4%). The statistical analysis was weighted to account for missing data.

4.2.1. Salt iodine content - General Stratum

In the General stratum 833 salt samples were collected and analyzed for SI content (Table 5). All salt samples contain some amount of iodine (the lowest concentration being 4.8 mg/kg). The total mean SI content of all salt samples in the General stratum was 32.9mg/kg (95%CI: 32.4-33.5mg/kg). None of the 833 salt samples was un-iodized; the lowest SI content was 4.8mg/kg. The SI content was below 15mg/kg in 2.4% of samples, and 86.4% had an SI content from 25 to 55mg/kg.

Table 5. Salt iodine (SI) content by urban and rural location in the General stratum

Location	N	Mean SI	SE	95% CI	
Urban	620	33.4	0.35	32.7	to 34.1
Rural	213	31.8	0.47	30.9	to 32.8
All SAC	833	32.9	0.29	32.4	to 33.8

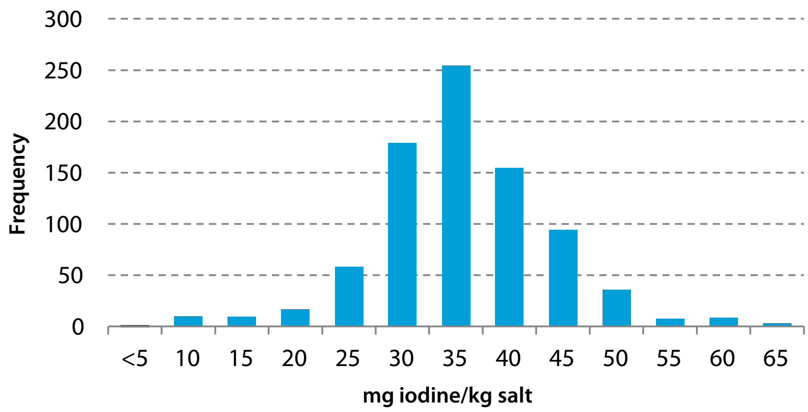
The SI content of household salt in urban areas (33.4mg/kg) was somewhat higher ($p<0.01$) than in rural areas (31.8mg/kg). Nevertheless, the distributions of SI contents by location were very similar (Fig. 1)

Table 6. Salt iodine (SI) content by region in the General stratum

Region	N	Mean SI	SE	95% CI	
Adjara	79	32.3	0.94	30.5	to 34.2
Tbilisi	290	33.1	0.50	32.1	to 34.1
Kakheti	64	33.6	1.03	31.6	to 35.7
Imereti	104	33.6	0.90	31.8	to 35.4
Samgrelo/ Zemo Svaneti	62	32.9	1.05	30.8	to 35.0
Shida Kartli	51	32.1	1.23	29.7	to 34.6
Kvemo Kartli	105	33.4	0.61	32.2	to 34.6
Guria	20	32.6	2.13	28.1	to 37.0
Samtskhe-Javakheti	36	31.4	1.03	29.3	to 33.5
Mtskheta-Mtianeti	17	28.9	1.29	26.2	to 31.7
Racha-Leckhumi and Kvemo/Svaneti	4	32.6	5.92	7.1	to 58.1
All SAC	833	32.9	0.29	32.4	to 33.5

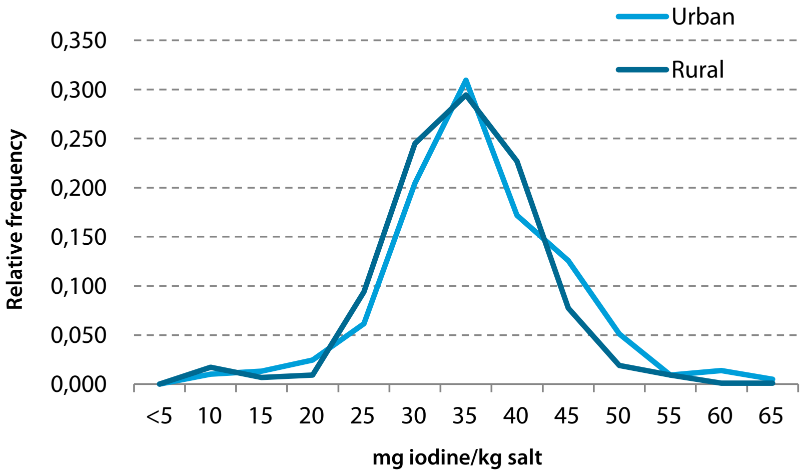
Mean SI content was quite uniform across the regions with no statistical significant differences between them (Table 6). Frequency distribution analysis (Fig. 2) showed normal pattern with 12.5% of samples below 25 mg/kg and only 2.3% over 50 mg/kg.

Fig. 2. Frequency distribution of salt iodine content in the General stratum



Frequency distribution patterns were very quite similar for SI content in samples collected in urban and rural locations (Fig. 3)

Fig. 3. Frequency distribution of salt iodine content in urban and rural locations within the General stratum



4.2.2. Salt iodine content - Mountain Stratum

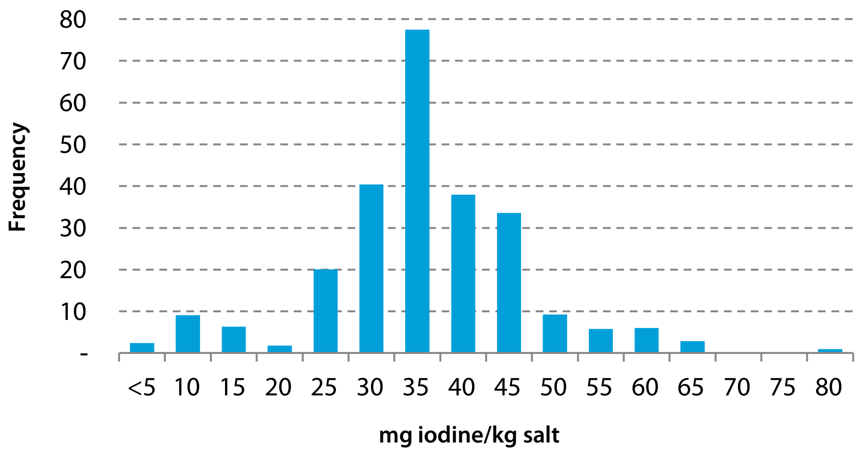
In the Mountain stratum 254 salt samples were collected and analyzed for iodine (SI) content (Table 7). All salt samples contain some amount of iodine (the lowest concentration being 2.7 mg/kg).

Table 7. Salt iodine (SI) content by regions in the Mountain stratum

Regions	N	Mean SI	SE	95% CI	
Adjara	186	33.2	0.81	31.6	to 34.8
Svaneti	68	34.1	1.24	31.6	to 36.6
All Mountain	254	33.4	0.68	32.1	to 34.8

All the 254 salt samples brought from households in the Mountain stratum contained some iodine, the lowest content being 2.7mg/kg. The overall mean SI content was 33.4mg/kg (95%CI: 32.1-34.8mg/kg). The SI content was below 15mg/kg in 7.0% of samples, and 80.5% had SI content from 25 to 55mg/kg (Georgia standard). The proportion of inadequately iodized salt in the Mountain stratum (7.0%) was significantly higher ($p<0.05$) than in the general survey (2.4%).

Fig. 4. Frequency distribution of salt iodine content in the Mountain stratum



Frequency distribution analysis (Fig. 4) showed normal pattern with 15.3% of samples below 25 mg/kg and only 2.8% over 50 mg/kg.

4.2.3 Market share and salt iodine content by producer origin

During the assessment of SAC, a knowledge, attitude and practice (KAP) survey of iodized salt has been performed in both general and mountain strata. Detailed results of KAP survey are presented in section 4.5 of this Report. Among other questions (Questionnaire - **Annex 1**), parents of SAC were requested to write down the name of salt producers from the package. The salt used for human consumption in Georgia is imported from various sources. Since there are many different brands in the market, the salt supplies (brands) were coded by country of origin.

The predominant type of iodized salt imported to Georgia (General stratum) is from Ukraine (63%), followed by Azerbaijan (19%) and Turkey (9%). Similar to the General stratum, salt from Ukraine is the predominant type of salt in the households of the Mountain stratum: 60% in Adjara and 69% in Svaneti (Table 8).

Table 8. Proportion (in %) of household usage of iodized salt imported from different countries to Georgia

Stratum	Country of origin	Urban cohort	Rural cohort	Entire stratum
General	Ukraine	59.3	72.3	62.9
	Azerbaijan	22.4	10.4	19.1
	Turkey	10.6	6.4	9.4
	Iran	2.1	6.1	3.2
	Other	5.6	4.8	5.4
		Adjara	Svaneti	Entire stratum
Mountain	Ukraine	59.5	69.1	65.1
	Azerbaijan	23.6	2.9	11.7
	Turkey	2.2	0.0	0.9
	Iran	8.7	20.6	15.6
	Other	6.0	7.4	6.7

The proportion of salt from Ukraine in the rural households (72%) of the General stratum is significantly higher ($p<0.05$) than in urban households. In contrast, the proportion of salt from Azerbaijan used in rural households (10%) is significantly lower ($p<0.05$) than in urban households (22%). This difference may be attributed to the fact, that rural population may prefer coarse rock salt from Ukraine while urban population may like fine salt of "Extra" grade from Azerbaijan.

In the Mountain stratum the second most prevalent type of salt, especially in Svaneti, was from Iran (16%) followed by Azerbaijan (12%), which was most prominent in Adjara. The distribution of type of salt by country origin in the Mountain stratum is quite similar to the finding in the rural households of the General stratum. Smaller proportion of households in the Mountain stratum use salt from Azerbaijan and larger - from Iran. The proportion of salt from Turkey is almost negligible in both Adjara and Svaneti.

The SI content in households from General stratum, classified by country of origin, is rather homogeneous. Although the SI content in salt from Azerbaijan is somewhat higher than any other source, no significant difference was found in SI content by country of origin (Table 9).

Table 9. SI content by country of origin in General stratum

Country of Origin	N	Mean SI	SE	95% CI	
Ukraine	330	32.5	0.40	31.7	to 33.2
Azerbaijan	103	35.3	0.88	33.6	to 37.0
Turkey	51	32.5	1.36	29.8	to 35.3
Iran	18	31.8	1.52	28.5	to 35.0
Other	33	31.9	1.32	29.2	to 34.6
Data missing	298	32.9	0.50	31.9	to 33.9
All salt samples	833	32.9	0.285	32.4	to 33.5

In the Mountain stratum only one single salt sample was reportedly imported from Turkey. This sample had 40.2mg/kg iodine content and was deleted from further statistical analysis.

Table 10. SI content by country of origin in the Mountain stratum

Country of Origin	N	Mean SI	SE	95% CI	
Ukraine	66	33.0	1.18	30.7	to 35.4
Azerbaijan	10	35.2	2.36	29.7	to 40.6
Iran	17	38.8	2.73	33.0	to 44.6
Other	7	32.8	4.09	22.8	to 42.8
Data missing	153	32.9	0.92	31.1	to 34.7
All salt samples	253	33.4	0.682	32.1	to 34.8

Similar as for the General stratum, the distributions of SI content by country origin was quite even and no statistical difference was found among SI contents by production origin, even though the salt from Iran had higher SI content than other sources.

4.3. Comparison and analysis of salt iodine (SI) findings in the General and the Mountain Strata

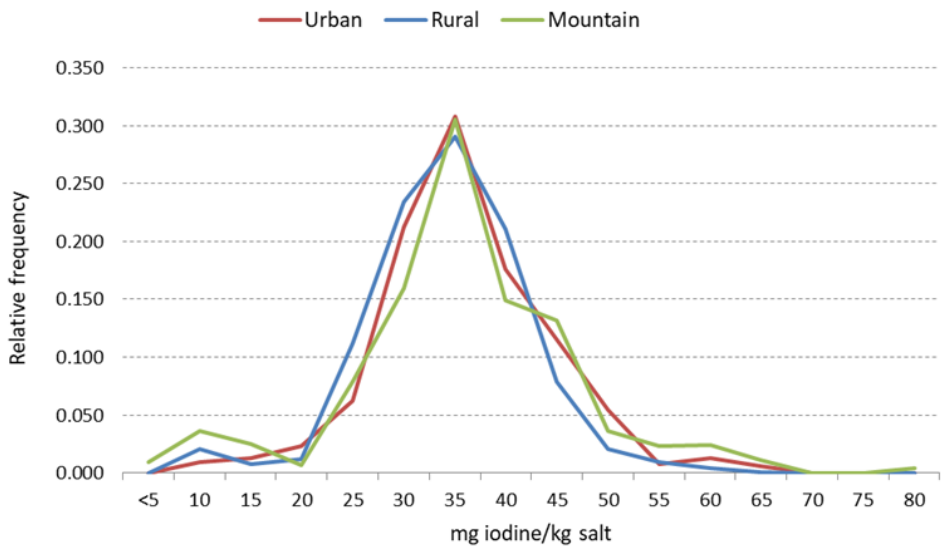
The comparison illustrates that the SI content in households of the urban and rural cohorts in the General stratum and Mountain stratum are similar (Table 11, Fig. 6). In comparison, the SI content in the rural cohort of the General stratum was lower by ±5% (1.6mg/kg) on average. This small difference was related to a higher proportion of SI values between 25 and 35mg/kg and a smaller proportion of SI values in the range from 45 to 55mg/kg in the rural cohort compared with the other cohorts.

Table 11. Salt iodine findings by strata and cohorts

Stratum/Cohort	N	Mean SI	SE	95% CI	
General/Urban	569	33.4	0.35	32.7	to 34.1
General/Rural	264	31.8	0.47	30.9	to 32.8
Mountain	254	33.4	0.68	32.1	to 34.8

The SI content of household salt in the General and Mountain strata was very similar for most sources, except for salt imported from Iran. The difference between the SI content of household salt from Iran in the general survey (31.8mg/kg) was significantly lower (p<0.05) than that in the Mountains (38.8mg/kg).

Fig. 6. Relative frequency distribution of iodine content in salt by urban and rural cohort in General stratum and Mountain stratum (both cohorts combined).



None of the 1097 salt samples collected in this assessment was un-iodized. All salt samples contain some amount of iodine, the lowest concentration being 4.8mg/kg in the General stratum and 2.7mg/kg in the Mountain stratum.

In the General stratum the SI content was below 15mg/kg only in 2.4% of samples, and 86.4% had an SI content from 25 to 55mg/kg, as per Georgia salt standard. In the Mountain stratum the SI content was below 15mg/kg in 7.0% of samples, and 80.5% had SI content from 25 to 55mg/kg. The proportion of inadequately iodized salt in the Mountain stratum was significantly higher (p<0.05) than in the general survey (2.4%). The SI content of household salt in urban areas (33.4mg/kg) was somewhat higher (p<0.01) than in rural areas (31.8mg/kg). Nevertheless, the distributions of SI contents by location were very similar (Fig. 6).

Results of 2017 assessment confirm excellent coverage rate: over 90% of households in Georgia consume adequately iodized salt with SI content > 15mg/kg both in General and Mountain stratum. Quality of iodized salt was remarkably good for all major brands of salt imported from various countries. It may be concluded, that Georgia has successfully sustained targets and goals of IDD elimination program (Table 1).

4.4. Status of iodine nutrition in SAC nationwide and by regions

The raw UIC data were corrected for individual variation, based on repeat urines of 192 SAC (Table 12).

Table 12 Correction of raw UIC data for individual variations

Source of Variation	Variance	SD	**SD Ratio Between/Total**
Within SAC	0.114	(Within variation = 41% of total variation)	
Between SAC	0.162	0.402	**0.766**
Total	0.276	0.525	

Using the SD ratio, UIC values for each SAC were corrected with the IOM formula [6]. Adjusted UIC = [(person's UIC – group mean)*SD ratio] + group mean

4.4.1 General stratum

For the General stratum UIC data were available for 847 SAC; i.e., coverage of 94.1%. The statistical analyses are weighted by urban/rural area within regions for missing data (Fig 7)

Fig. 7. Frequency distribution for UIC in the General stratum (adjusted vs. non-adjusted)

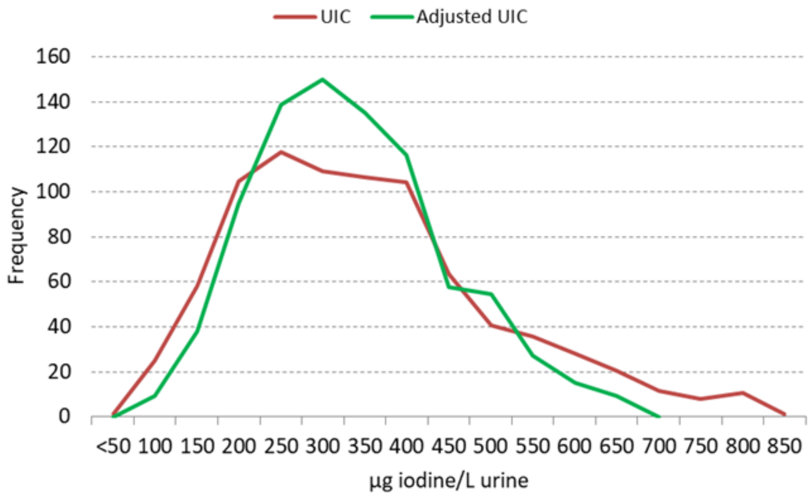


Table 13. Spot UIC distributions, and adjustment for within-person variation in grade III-IV SAC, General stratum

Centile	Raw UIC values from spot urines	UIC adjusted for within-person variation
10th	149	174
25th	208	224
50th	302	298
75th	406	374
90th	538	464

As shown in Figure 7 and Table 13, the distribution of adjusted UIC data is less spread out than the raw spot UIC values. Adjusted UIC data were used for further data processing.

Table 14. Adjusted UIC by urban and rural location

Location	N	Median	Inter-quartile interval	
Urban	579	304	233	to 380
Rural	268	275	212	to 361
All SAC	847	298	224	to 374

Adjusted median UIC in SAC nationwide (General Stratum) was 298µg/L that is within the range of the optimum iodine nutrition (100-299 µg/L) but rather close to upper limit (Table 14). Urban SAC have 10% (29µg/L) higher UIC (304µg/L) than rural SAC (275µg/L). Frequency distribution of adjusted UIV levels by urban and rural location in presented in Fig 8.

Fig. 8. Frequency distribution of adjusted UIC (µg/L) in SAC from urban and rural locations

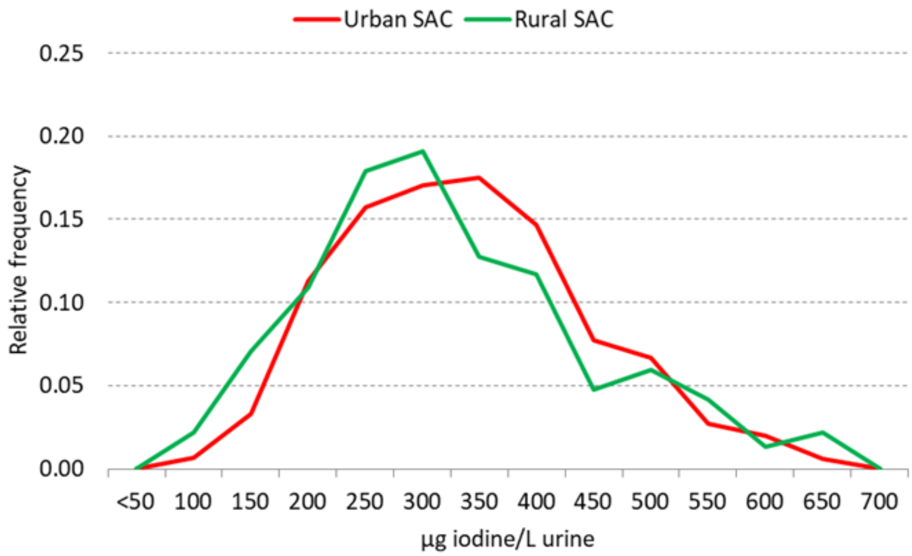
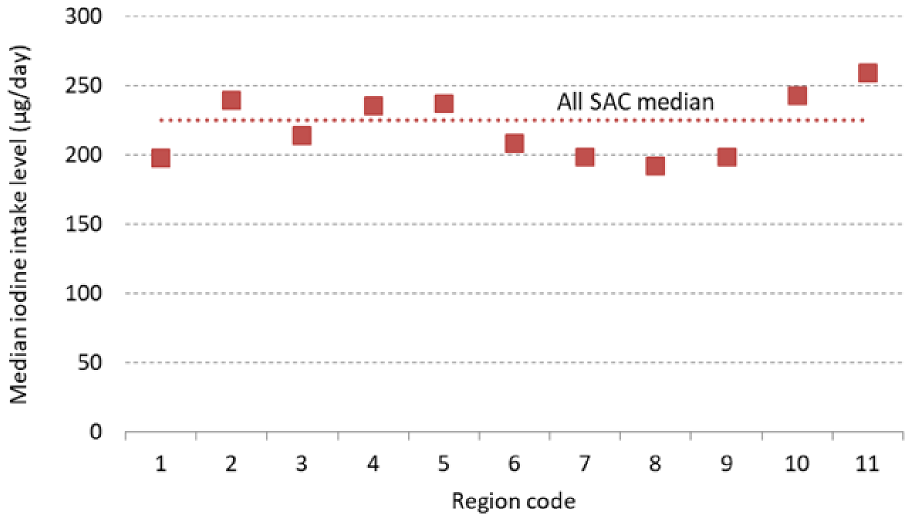


Table 15. Distribution of adjusted UIC (µg/L) in SAC by regions of Georgia

Code and name of the region	N	Median	Inter-quartile interval	
1 – Adjara	81	286	211	to 369
2 – Tbilisi	294	315	251	to 383
3 – Kakheti	66	289	237	to 386
4 – Imereti	106	280	209	to 314
5 – Samegrelo/ Zemo Svaneti	63	310	246	to 371
6 – Shida Kartli	52	286	215	to 351
7 – Kvemo Kartli	107	258	204	to 336
8 – Guria	20	225	155	to 324
9 – Samtskhe – Javakheti	37	242	215	to 352
10 – Mtskheta – Mtianeti	18	308	259	to 401
11 – Racha – Lechkhumi and Kvemo Svaneti	4	327	222	to 405
All SAC	847	298	224	to 374

Distribution of adjusted median UIC levels by regions of Georgia is presented in Fig. 9 and Table 15. Lowest median UIC (225µg/L) was found in Guria, while the median UIC in Rach – Lechkhumi and Kvemo Svaneti) was the highest (327µg/L).

Fig. 9. Distribution of median UIC level (µg/L) by regions of Georgia (codes and names of the regions are presented in Table 14)



4.4.2 Mountain stratum

UIC data were available for 299 SAC; i.e., coverage of 92.3%. The statistical analyses are weighted by clusters within stratum for missing data.

Table 16A. Spot UIC distributions, and adjustment for within-person variation in grade III-IV SAC, Mountain stratum

Centile	Raw UIC values (µg/L) from spot urine collections	UIC values (µg/L) adjusted for within-person variation
10^{th}	125	146
25^{th}	178	192
50^{th}	247	247
75^{th}	368	335
90^{th}	468	403

Similar as for the General stratum, the distribution of adjusted UIC data of SAC in the Mountain cohort is less spread out than the raw spot UIC values. Adjusted UIC data (Table 16A) were used for further data processing.

Median UIC in SAC was 247 µg/L for entire Mountain stratum, as well as for both regions: Adjara (stratum code 70) and Svaneti (stratum code 90). Results are presented in Table 16B. No difference was found for the UIC in SAC between the two regions.

Table 16B. Adjusted UIC (µg/L) by regions in the Mountain stratum

Regions	N	Median	Inter-quartile interval
Adjara	237	247	194 to 327
Svaneti	62	247	180 to 337
All SAC	299	247	178 to 368

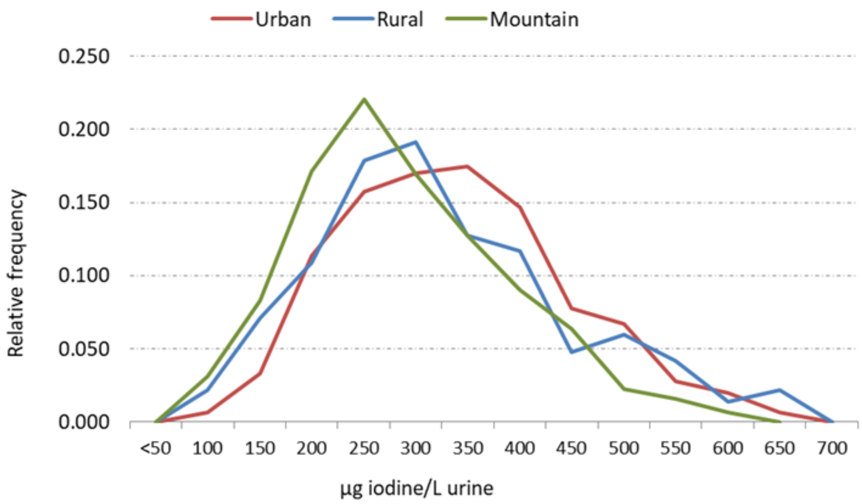
4.5. Comparison and analysis of urinary iodine concentration (UIC) findings in SAC in the General and the Mountain Strata

As shown in the Table 17 and the Fig. 10 below, median UIC findings in urban SAC were 29µg/L higher than in rural SAC (General stratum) and the median UIC of SAC in the Mountain stratum was 51µg/L lower than the median UIC in urban and rural SAC combined. Even though these are ample differences, median UIC findings in all the SAC groups are reaching sizably above the threshold for population iodine deficiency. Percent UIC values less than 100µg/L in the 3 cohorts were 0.6%, 2.2% and 3.1% of SAC in urban, rural and mountainous areas, respectively.

Table 17. Adjusted UIC findings (µg/L) by SAC stratum and cohort

Cohort/Stratum	N	Median	Inter-quartile interval
Urban SAC	579	304	233 to 380
Rural SAC	268	275	212 to 361
Mountain SAC	299	247	178 to 368

Fig. 10. Frequency distribution of UIC (µg/L) in urban and rural cohorts of the General stratum and Mountain stratum.



Median UIC in SAC nationwide in all cohorts (298µg/L) was within the range (100-299 µg/L) for optimum iodine nutrition of population, albeit shifted to higher values.

4.6. Comparison and analysis of iodine intake data in SAC in the General and the Mountain strata

A next step in the analysis will estimate the iodine intake of SAC, based on their UIC and body weight data; the findings were compared with their age-specific Estimated Average Requirement (EAR) and the Upper Limit (UL) of recommended iodine intake.

Iodine intake estimates were calculated from the adjusted UIC data of SAC with use of the equation proposed by IOM [7] as follows:

*Iodine intake (µg/day) = UIC (µg/L)/0.92*0.0009 (L/h/kg*24h/day)*Body weight (kg),*

or simplified:

*Iodine intake (µg/day) = UIC (µg/L)*0.0235*Body weight (kg).*

4.6.1. Analysis of iodine intake of SAC in the General stratum

Iodine intake data were available for 820 SAC; i.e. 91.1% coverage of expected. The data processing was weighted by urban/rural area within regions for missing data. The age-specific EAR values and the UL value for daily iodine intake, obtained from the IOM report [7], were compared with the iodine intake data of SAC to estimate the prevalence of inadequate (i.e., below EAR) and excessive (above UL) iodine intakes.

Of all SAC, 1.8% had iodine intake estimates below their EAR (inadequate intake) and 1.3% had iodine intake estimates above the UL (excessive intake). These findings are lower than the prevalence levels (2.3%) expected in a population with adequate iodine nutrition.

Fig. 11. Frequency distribution of iodine intake in SAC in Georgia (General stratum)

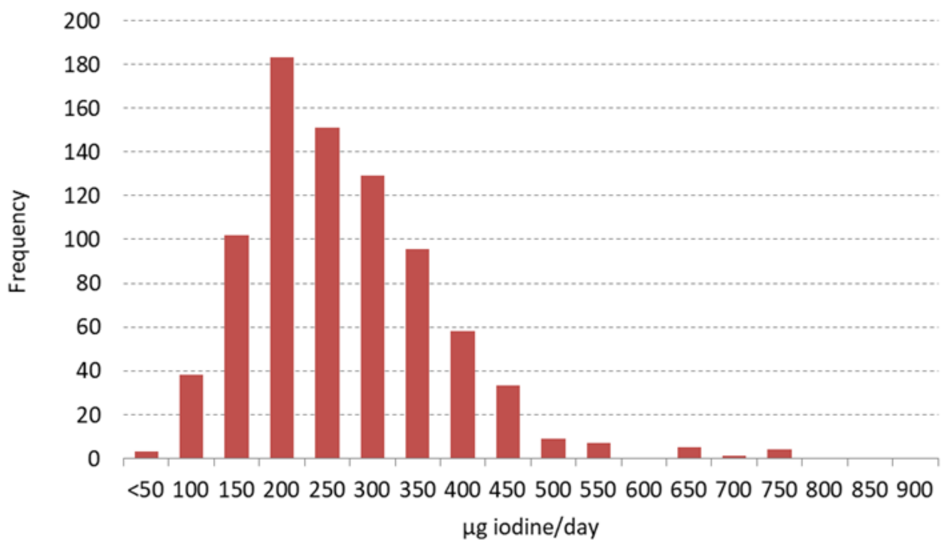


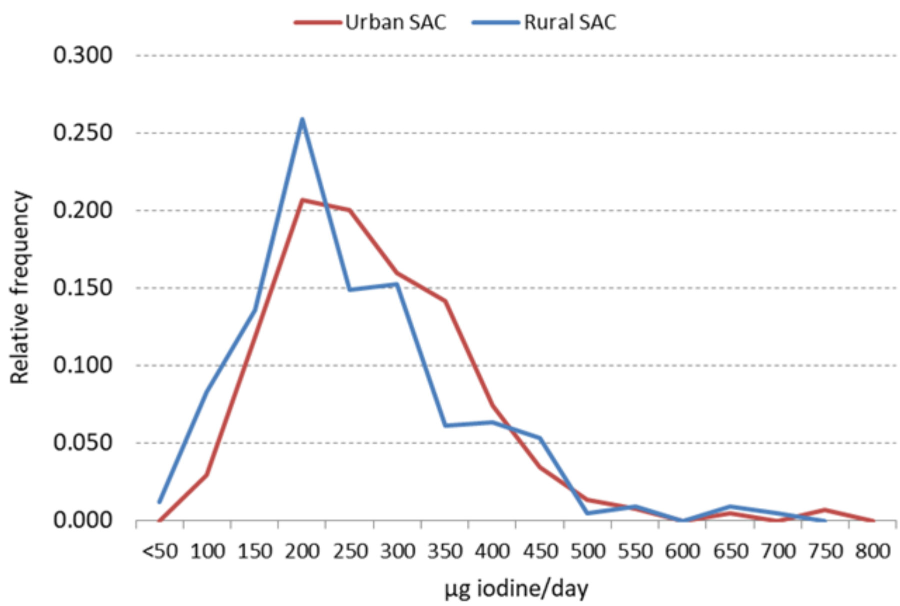
Table 18. Iodine intake distribution parameters

	Centiles				
N	10th	25th	50th	75th	90th
820	124	167	227	304	375

The median iodine intake estimate in SAC was 227µg/day, interquartile interval 167-304µg/day. Based on these findings (Table 18, Fig. 11) the overall iodine intake of SAC in Georgia is optimal.

The prevalence of iodine intakes below EAR was 0.7% in urban SAC and 4.5% in rural SAC. Even though the prevalence of insufficient iodine intake in rural SAC was higher than the expected value (2.3%) in a population with adequate iodine nutrition, the difference is not statistically significant. The prevalence of excessive iodine intake (i.e., above the UL) in urban SAC was 1.2% and in rural SAC 1.4%. Both estimates are lower than the expected value (2.3%) in a population with adequate iodine nutrition (Fig. 12)

Fig. 12. Relative frequency distribution of iodine intake in Georgia SAC by urban and rural location



Iodine intake in urban SAC was 12-13% higher than in rural SAC; in other words urban SAC had 29µg/day higher iodine intake than rural SAC. The iodine intake distributions (Fig. 12) illustrate the consistently higher iodine intake estimates of urban SAC throughout the range of iodine intake up to ±400µg iodine per day. Above the 400µg/day iodine intake level, the distributions show little difference between the urban and the rural SAC (Table 19).

Table 19. Iodine intake distribution parameters in urban and rural SAC

Location	N	Centiles				
		10th	25th	50th	75th	90th
Urban	560	134	169	234	311	374
Rural	260	103	153	205	284	379
All SAC	820	124	167	227	304	375

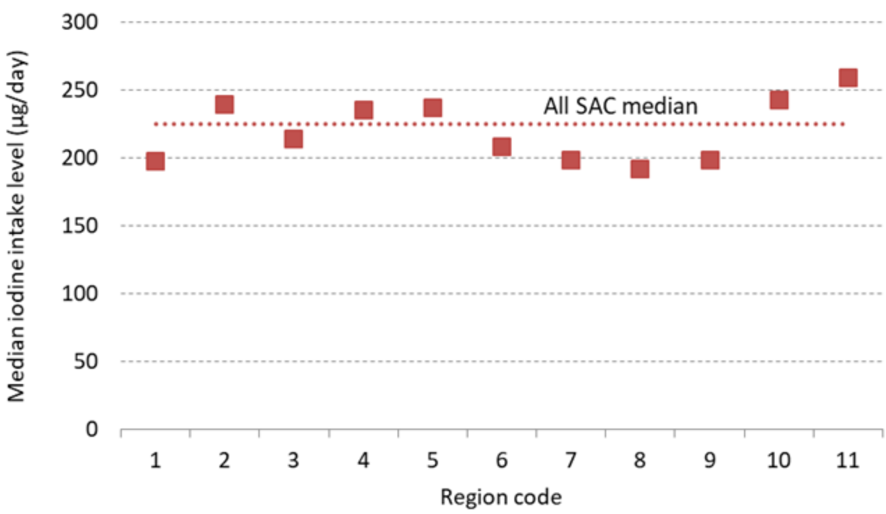
There was some variations in iodine intake in SAC by geographical regions of Georgia (Table 20, Fig. 13).

Table 20. Iodine intake in SAC by Georgia regions

Code/Region	N	Median	Inter-quartile interval
1 – Adjara	83	198	155 to 298
2 – Tbilisi	271	239	181 to 313
3 – Kakheti	80	214	168 to 316
4 – Imereti	84	235	168 to 312
5 – Samgrelo and Zemo Svaneti	64	236	172 to 321
6 – Shida Kartli	37	208	158 to 264
7 – Kvemo Kartli	83	198	150 to 268
8 – Guria	43	192	149 to 281
9 – Samtskhe-Javakheti	53	199	146 to 267
10 – Mtskheta-Mtianeti	17	243	199 to 309
11 – Racha-Lechkhumi and Kvemo Svaneti	4	259	224 to 390
All SAC	820	227	167 to 304

Lowest median iodine intake (192µg/day) was found in Region 8 (Guria) and the median iodine intake in Region 11 (Rach-Lechkhumi and Kvemo Svaneti) was highest (259 µg/day).

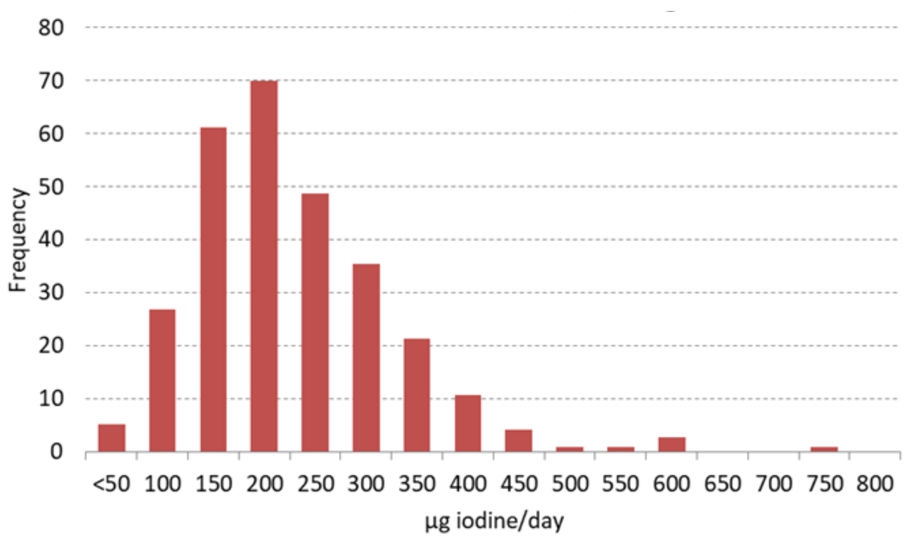
Fig. 13. Median iodine intake in SAC by regions of Georgia (codes and names of regions are presented in Table)



4.6.2. Analysis of iodine intake of SAC in the General stratum in the Mountain stratum

In the Mountain stratum iodine intake estimates were available for 289 SAC; a coverage of 89.2%. The statistical analysis was weighted by clusters within strata for missing data. In the Mountain stratum, 4.8% of all SAC had an iodine intake estimate less than their EAR (inadequate intake) and 0.3% had an iodine intake estimate above the UL (excessive intake).

Fig. 14. Frequency distribution of iodine intake in SAC in Georgia (Mountain stratum)



The median iodine intake in Mountain SAC was 184µg/day, interquartile range 141-254µg/day (Fig. 14, Table 20).

Table 20. Iodine intake distribution parameters in SAC (Mountain stratum)

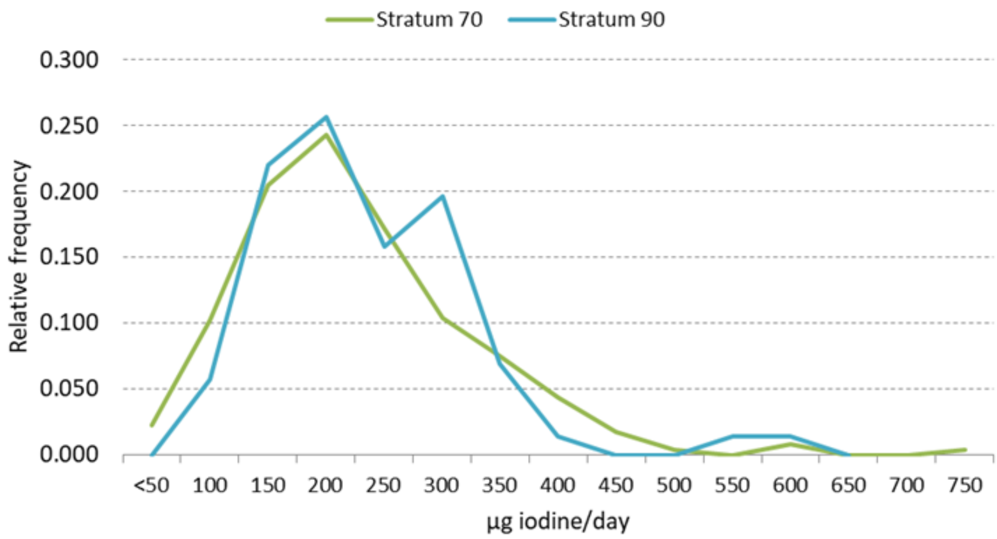
	Centiles				
N	10^{th}	25th	50th	75th	90th
289	99	141	184	254	322

In Adjara (stratum 70), 5.3% of SAC had an iodine intake estimate below the EAR and in Svaneti, iodine intake estimates of 3.0% of SAC were below their EAR. In Adjara, the iodine intake estimate of one SAC was above the UL (0.4% of stratum) and no children in Svaneti were found with an estimated iodine intake above the UL.

Table 21. Iodine intake distribution in SAC (Mountain stratum) by cohorts

Cohorts	N	Centiles		
		25th	50th	75^{th}
Adjara = 70	229	141	185	253
Svaneti = 90	60	133	172	257
All Mountain SAC	289	141	184	254

Fig. 15. Relative frequency distribution of iodine intake in SAC (Mountain stratum) by location (Adjara and Svaneti)

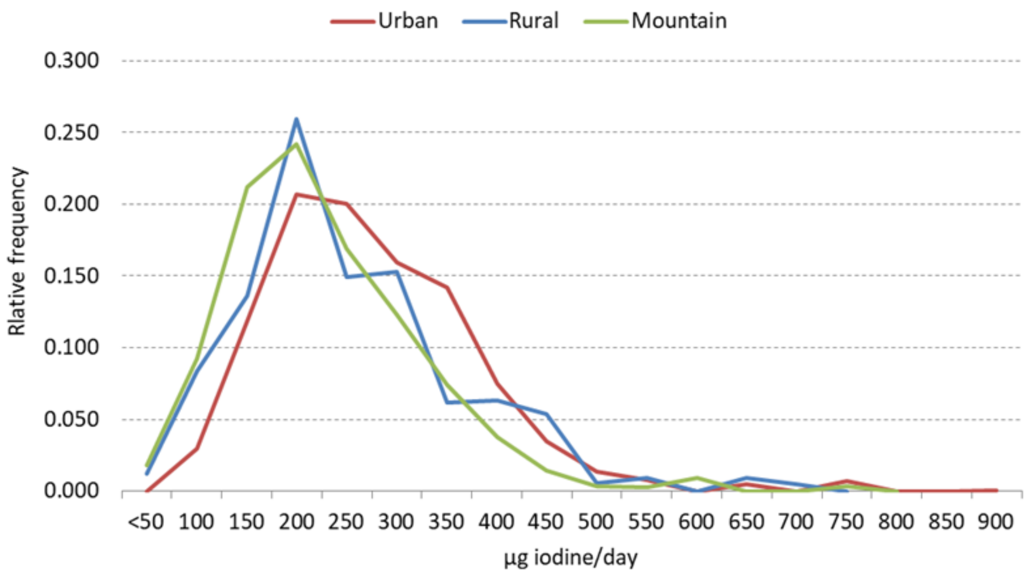


The Table 21 and Fig. 15 above illustrate that, despite the higher prevalence of insufficient iodine intake in Adjata, the iodine intake values of SAC in the mountains of Adjara region (stratum 70) are higher than those of their peers in Svaneti region.

4.6.3. Comparison between iodine intake findings in the General and the Mountain strata

Frequency distribution of iodine intake in SAC by cohorts (urban and rural) and stratum (Mountain) in presented in Fig. 16. The analysis shows that the iodine intake of Mountain SAC is lower by 43µg/day (19%) than of SAC in the General stratum. Compared to the age-specific EAR, the prevalence of deficient iodine intake in rural SAC (4.5%) and Mountain SAC (4.8%) is comparable and ±6-7 times higher than in urban SAC (0.7%).

Fig. 16. Relative frequency distribution of iodine intake in SAC by cohorts (urban and rural) and stratum (Mountain)



The highest prevalence of inadequate iodine intake (5.3%) was found in the Adjara Mountains. Excessive iodine intake (above the UL of 600µg/day) was prevalent in all cohorts below the 2.3% level expected in a population with optimum iodine nutrition (Table 22).

Table 22. Iodine intake in SAC by cohort/stratum and prevalence deficient and excessive iodine intake

	Iodine intake in SAC by cohort				Prevalence of intake	
Cohort	**N**	**Median**	**Inter-quartile interval**		**Deficient**	**Excessive**
Urban SAC	560	234	169	to 311	0.7%	1.2%
Rural SAC	260	205	153	to 284	4.5%	1.4%
Mountain SAC	289	184	141	to 254	4.8%	0.3%

Iodine intake findings support the overall conclusion that successful USI program led to optimal iodine nutrition of population nationwide. Moreover, there are no sizable difference in level of iodine intake between general population and those who reside in the mountain areas (Adjara and Svaneti) that historically has been severely iodine deficient with many cases of goiter and even cretinism. Universal high coverage with quality iodized salt that was reached by effective prohibition of non-iodized import provided sustainable source of iodine in everyday diet to all population of Georgia.

4.7 Comparison and analysis of iodine source apportioning in SAC

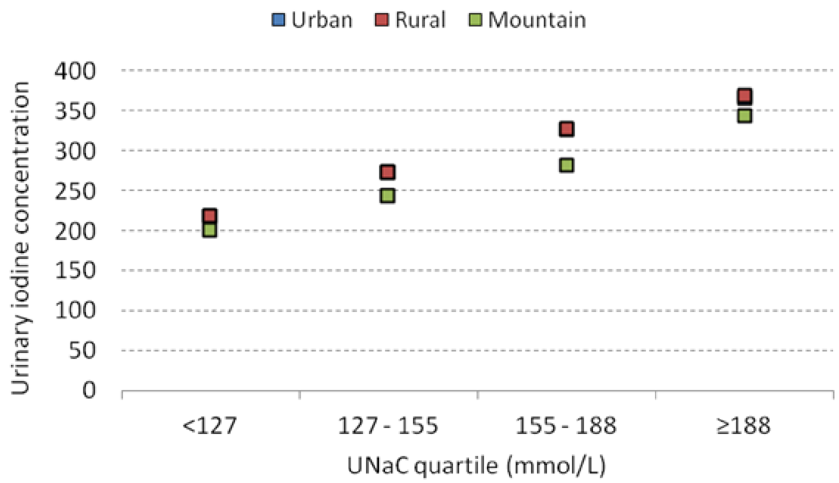
The underlying purpose of measuring sodium concentrations in the urine collections of the SAC during the 2017 iodine survey in Georgia was to explore the relationship between the dietary use of iodized salt and the resulting iodine status in the population. Because after intake, ultimately, both the iodine and sodium are excreted in urine, it was reasoned that, because a significant part of the iodine status in the SAC depends on iodized salt in manufactured foods and on its use in the households, the iodine and sodium amounts in the urine should be associated. Then, the sodium amount in urine could be used to examine the role of salt iodization in ensuring the dietary need for sufficient iodine. More detailed information in UNaC in SAC is presented in **ANNEX 5**.

4.7.1. Relationship of UIC with UNaC and SI levels

Adjusted UIC and UNaC variables were used for further analysis. First, to depict the association of the UIC levels in SAC with the UNaC levels in the same children, the distribution of UNaC data was separated into four quartiles and the median UIC derived for each UNaC quartile. Results of this analysis by SAC cohort are illustrated in the Figure 17 below.

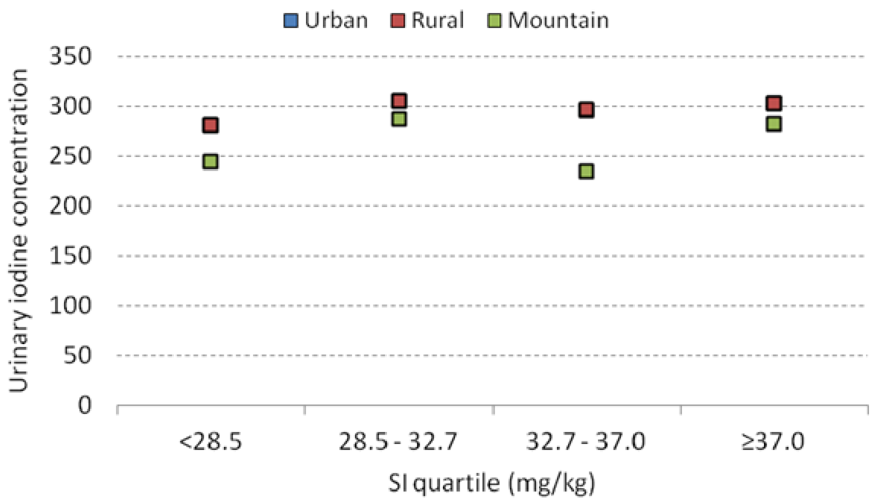
A clear increase in UIC is apparent with each increment of UNaC quartile; the overall increase in median UIC amounts to about 140-150µg/L over the range of UNaC quartiles, or ±35-40µg/L for each quartile. The median UIC levels in the urban and rural SAC are completely overlapping, while in the mountain SAC, the median UIC findings are ±20µg/L lower than those in the urban and rural SAC (general survey) within each UNaC quartile.

Fig. 17 Association of the UIC levels in SAC with the UNaC quartile



Similarly, the distribution of SI data in SAC were separated into quartiles and related their median UIC levels by SAC cohort, with results illustrated in the Figure 18. In contrast to the steep relationship between UIC and UNaC (Fig. 17), the median UIC levels by SI quartile show only a weak association, with median UIC levels increasing by only 20 (urban and rural SAC) to 40µg/L (mountain SAC) over the SI range. Again the UIC levels in urban and rural SAC are completely overlapping, while the median UIC findings in the SAC of the mountains lower by about 40µg/L.

Fig. 18 Association of the UIC levels in SAC with the SI content quartile



4.7.2 Dependency of the iodine intake on the UNaC and SI values in all children

Descriptive data: Information from 982 SAC with all data available was used for the analysis. In these children, the mean UNaC was 159mmol/L (SD 41.2) and the SI content in salt from their households was 33.1mg/kg (mean, SD 9.02). The mean total LN I2 intake was 5.363, which is equivalent to 213µg/day, and the median iodine intake in all the SAC was 221µg/day.

Table 23.

Variable	Mean	SD	Minimum	Median	Maximum
AdjUNaC	159	41.2	69	155	282
SI content	33.1	9.02	2.7	32.8	63.8
LNI2intake	5.363	0.4598	3.643	5.399	6.761
I2 intake	213		38	221	864

Analytical data: Findings from multiple regression analysis (Table below) shows that the LN iodine intake is being explained by a constant (intercept) value of 4.465, which is equivalent to 90µg/day of iodine, plus the combined effects of the UNaC (0.0045, or 4.5% per 10mmol/L) and the SI (0.0054, or 5.4% per 10mg/kg) variables. The effect of the UNaC variable on the iodine intake is highly significant (t=14.0; p<0.0001) while the SI variable has a somewhat smaller, but still very significant effect on the iodine intake levels in the SAC (t=3.65; p=0.0003).

Table 24.

Parameter	Estimate	95% CI	t	p-value
Constant	4.465	4.322 to 4.609	61.14	<0.0001
AdjUNaC	0.0045	0.0039 to 0.0052	14.00	<0.0001
SI content	0.0054	0.0025 to 0.0083	3.65	0.0003

Interpretation: Using the regression estimates reported in the above Table, the total iodine intake can be apportioned to the three dietary iodine supply sources described in the background section (native, food salt and household salt). The regression technique calculates the intercept value as the iodine intake level without the effects of the UNaC and the SI variables; this is interpreted as the iodine intake from the native food iodine source, because both the UNaC and the SI have the value zero in this calculation. Thus, the native food iodine intake in all SAC is obtained as the back-transformed value of 4.465, which corresponds with a median of 90µg/day or 41% of the total I2 intake of SAC.

Second, to obtain an estimate for the iodine intake from food salt, the intercept (4.465) finding is used together with the regression estimate for UNaC (0.0045) and the mean UNaC of the SAC (159mmol/L), while leaving the SI estimate out of consideration (which means the SI variable remains at zero). The food salt intake source is obtained from the back-transformed iodine intake value of 4.465+0.0045x159, or 185µg/day and subtraction of the native iodine intake estimate. This yields an estimate for median food salt iodine intake of 95µg/day, or 43% of the total iodine intake of all SAC.

The final step in estimating the iodine intake sources relates to the intake of iodine from household salt. This iodine intake source estimate is derived as the difference between the total median intake (221µg/day) and the sum of native and food salt iodine intakes (90+95=185µg/day); Thus, the estimated median iodine intake from household salt is 36µg/day, or 16% of the total median iodine intake of all SAC.

4.7.3 Dependency of iodine intake on UNaC and SI by SAC cohort

The above regression calculations were repeated for each SAC cohort separately to obtain group-specific estimates of iodine intake portions for urban SAC, rural SAC and mountain SAC respectively. The results are summarized in the Tables below.

Table 25. Iodine intake sources (Median Group Iodine Intakes) in µg/day

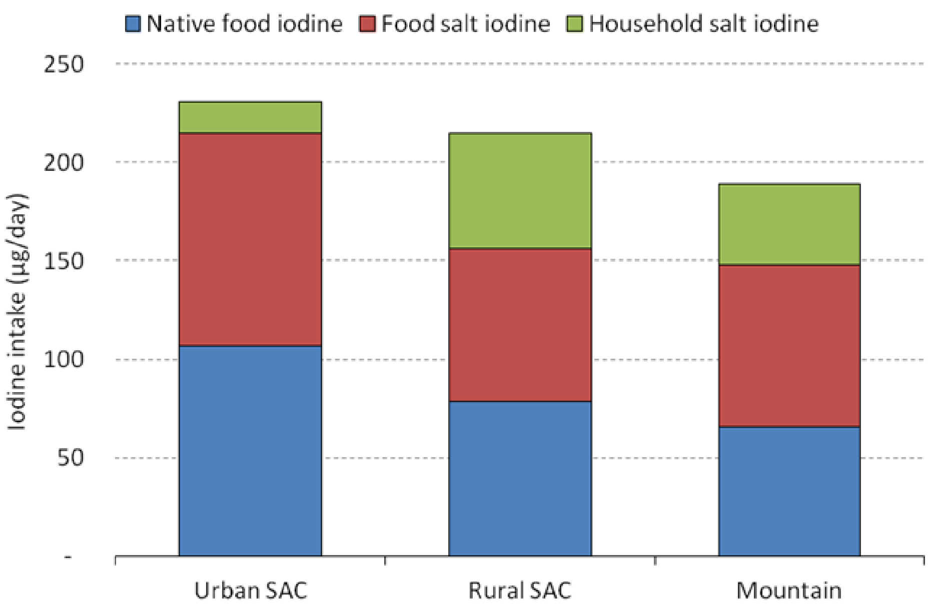
Source of intake	Urban SAC	Rural SAC	Mountain	All SAC
Native food iodine	107	79	66	90
Food salt iodine	108	78	82	95
Household salt iodine	16	59	41	36
Group Median iodine intake	231	215	189	221

The analysis revealed differences in amounts and proportions of iodine intake sources across SAC cohorts. In urban SAC, the iodine intake amount and proportion of dietary native food iodine (107µg/day) is sizably greater than in the rural (79µg/day) and the mountain (66µg/L) cohorts. In contrast, the amount and proportions of iodine intake from household salt in the rural (59µg/day) and mountain (41µg/day) SAC groups exceeds that in the urban SAC (16µg/L).

Table 26. Iodine intake sources (Portions of Group Iodine Intake)

Source of intake	Urban SAC	Rural SAC	Mountain	All SAC
Native food iodine	46%	37%	35%	41%
Food salt iodine	47%	36%	44%	43%
Household salt iodine	7%	27%	22%	16%

Fig. 19 Iodine intake sources by child cohort in Georgia

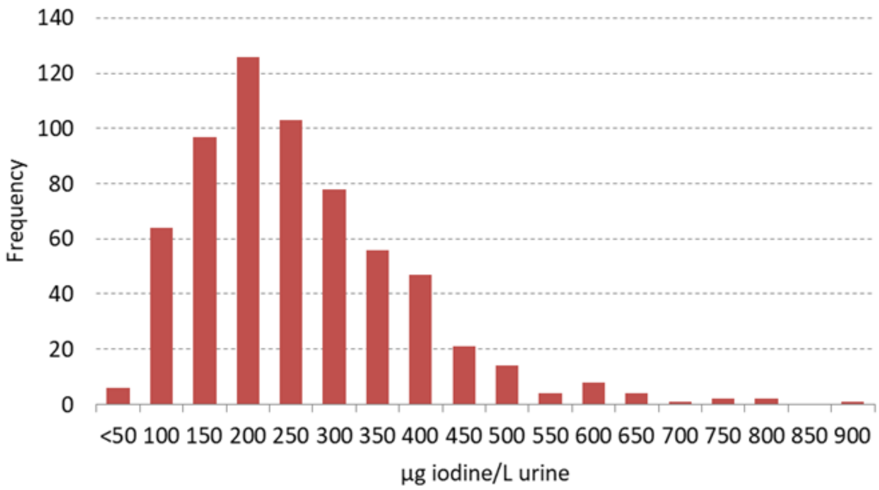


These differences are illustrated in the Figure 19, which shows the accumulation of the different iodine intake source estimates to the total iodine intake. The Figure 19 shows the relative small contribution of the household salt iodine intake and the sizably higher contribution of the native iodine intake in the urban SAC, compared to their peers in the rural and the mountain cohorts. The implication is that, compared to urban areas, the use of well-iodized household salt in the rural and mountainous areas are of relatively great importance in ensuring optimum iodine nutrition.

4.8. Status of iodine nutrition in PW

The age of all PW was 27y (SD 6.0). On average, the PW were 2.7 months pregnant (SD 1.2) and 87.0% (n=554) were in their 1st trimester of pregnancy.

Fig. 20. Frequency distribution of UIC in pregnant women



The median UIC in the 634 PW was 211µg/L. This finding suggests optimal iodine status of PW in Georgia as the level is conveniently in the middle of the 150-250µg/L range (Table 23) suggested by international convention for women during pregnancy [1, 8].

Table 27. Epidemiologic criteria for assessing iodine nutrition based on median urinary iodine concentrations in PW [1, 8]

Median UIC (µg/L)	Iodine intake	Iodine nutrition status
<150	Insufficient	Iodine deficiency
150-249	Adequate	Optimal
250-499	Above requirements	-
>500	Excessive	In excess of the amount required to prevent and control iodine deficiency

The UIC data from this survey are not normally distributed, as the Fig. 20 above illustrates. A re-analysis of the log-transformed UIC data found a geometric mean of 203µg/L which is essentially the same as the non-transformed UIC finding. The median UIC of the 541 PW who were in the 1st trimester of pregnancy was 211µg/L (geometric mean value 205µg/L), which again is very similar as for the findings among all the PW.

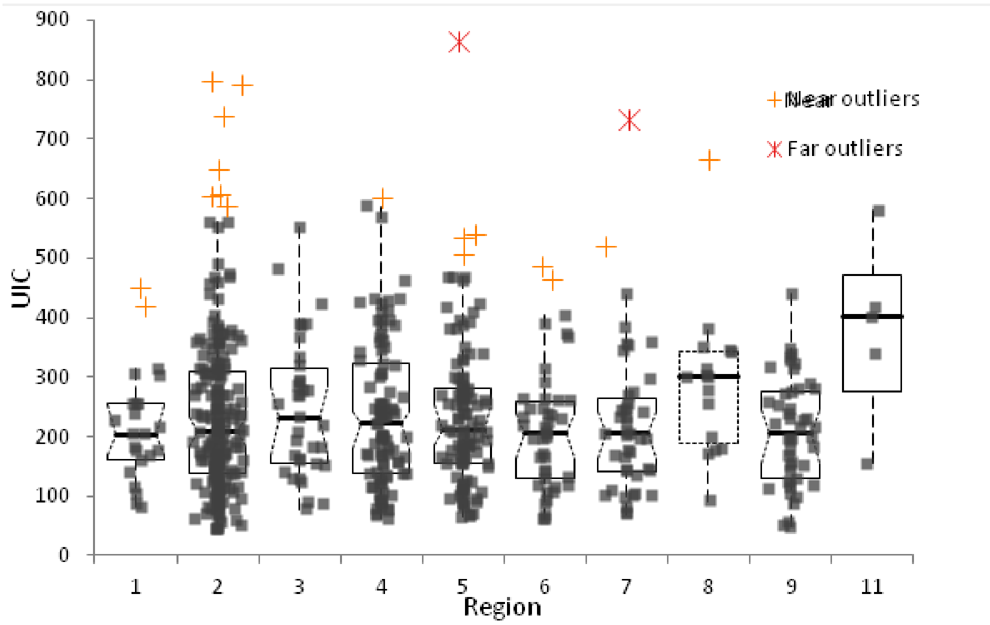
Of all PW, 59.6% reported to live in rural households and 40.4% in urban. The median UIC in rural PW was 226µg/L and 205µg/L in urban PW. Among the women in their 1st trimester of pregnancy, the median UIC findings were 223µg/L in the rural and 207µg/L in the urban PW. Given the high dispersion of UIC values which is typical for spot urine collections, these differences are minor.

The median UIC in PW who reported having used iodine supplements in the past was 209µg/L; in PW who stated the use of supplements at the time of urine sampling, the median UIC was 227µg/L and among those who reported never having used a supplement, the median UIC was 211µg/L. The finding of higher UIC values among the supplement users is not surprising. However, the typical dispersion of UIC values in spot urine samples does not permit an interpretation based on statistical testing of these differences.

In 77 women who reported having had a thyroid problem before pregnancy, a median UIC of 218µg/L was found; in 478 women who responded with "no" on this question, the median UIC was 211µg/L. In those who reported a pre-pregnancy thyroid problem, 42 (54.5%) stated having used an iodine supplement previously, while 4 (5.2%) were using a supplement at the time of examination.

The median UIC across regions were in the range (from 203 to 232 µg/L) indicative of optimum iodine nutrition, no statistically significant differences were found (Fig. 21). The median UIC levels found among the PW in regions 8 and 11 are beyond the range of adequate iodine status (150-249 µg/L). However, these findings are not excessive (>500µg/L) and they are based on a very mall number of observations in each region

Fig. 21. Median UIC levels (µg/L) in PW in Georgia by Regions (see Table 14 for names of the regions by code)



4.9. Assessment of knowledge, attitude and practice (KAP) of iodized salt and iodine supplements use by population in Georgia

A survey of knowledge, attitude and practice (KAP) of iodized salt and iodine supplement use has been performed in both general and mountain strata. Parents of SAC were requested to complete a questionnaire (**ANNEX 3**). In total, 894 questionnaires were completed by SAC parents in the General strata, 325 – in the Mountain strata and 663 - by PW.

The large majority of population reported knowledge of the existence of iodized salt: 91.6% of SAC parents in the General stratum (93.4% in urban and slightly less - 87% in rural areas), 87.5% in the Mountain stratum and 81% of PW. Surprisingly, relatively small proportion of respondents reported use of iodized salt at home: 57% in the General stratum (61% in urban and 46% in rural areas) and only 34% in the Mountain stratum; 36.8% of PW reported that they use iodized salt in their household. However, as shown in the previous chapters all salt in Georgia is currently iodized and non iodized salt is not available in the retail trade outlets.

Those reporting to use salt in a polybag with label were in the majority in all the surveyed groups: 78.6% in the General stratum, 78,5% in the Mountain stratum and 71.9% of PW. The majority reported using salt imported from Ukraine. More information about origin of iodized salt in Georgia is presented in section 4.2.3 of this report.

Only small proportion of SAC parents reported use of iodine supplement (such as Jodomarine™, Jodbalance™, potassium iodide): 0.7% SAC in the General stratum at the time of the assessment and 10.9% sometime before. In the Mountain stratum 3.4% of SAC were taking supplements at the time of assessment and 13.4% - sometime before. The majority of SAC (88,5% and 82.3% respectively) never took iodine supplements. About one-third of PW reported the use of iodine supplements in the past (25.9% of all PW) or at present (6.8% of all PW). As presented in the previous chapters, there was no any meaningful effect of iodine supplementation on status of iodine nutrition of SAC and PW. Optimum iodine nutrition in Georgia was achieved due to universal use of quality iodized salt.

Of the past and present iodine supplement users among PW, 3% reported that an OBG specialist was the prescriber; 34% reported a prescription by an endocrinologist, 54% another physician and 4% took the supplement on her own initiative. In the General stratum in 52% of cases iodine supplements for SAC were prescribed by pediatrician and in 25.6% - by endocrinologists. In the Mountain stratum, however, 87.5% of SAC took supplements at the initiative of parents (significantly more than in the General stratum – 21%).

Of all PW, 12.5% reported having a thyroid problem at the time of examination; 75.4% reported not having a thyroid problem while the remaining 12.1% of PW either didn't know or did not record an answer.

On knowledge about the benefits of iodine, 14.5% of PW stated goiter prevention; 8.9% mentioned mental development; 8.3% indicated development of the fetus and 36.8% responded with "all the above". Interesting enough that over 50% of SAC parents stated goiter prevention as the main benefit of iodine, over 30% - prevention of mental retardation and fetus development problems and over 45% - "all the above". There were significant differences in knowledge about benefits of iodine between urban and rural population.

The majority of PW (70.3%) and parents of SAC (61.1%) reported having no thyroid problems in the family and 18.1% of PW and 24.5% of SAC parents responded affirmative on this question. Current or recent smoking (i.e., before pregnancy) was reported by only by 5.6% of PW.

More detailed information of questionnaire responses is provided in **ANNEX 4** of this Report.

5. DISCUSSION AND CONCLUSIONS

Iodine is an essential nutrient for the synthesis of thyroid hormones that are critical for brain development. Iodine deficiency in utero and in early childhood damages the developing brain, making it one of the most important preventable causes of brain damage worldwide. Fortunately, through salt iodization, iodine deficiency is among the simplest and least expensive of nutrient deficiencies to prevent [8].

There has been remarkable progress in the global and regional efforts to eliminate IDD over the past two decades. In Georgia efforts to ban importation of non-iodized salt and introduce USI started in the mid-1990s. After adoption of USI legislation, a national iodine survey was conducted in Georgia in 2015 with UNICEF support. The median UIC in SAC was 320.7 µg/L, and only 4.4% of urinary samples were below 100 µg/L. While median UIC was higher than the upper limit for optimum iodine nutrition, it was considered that the country reached the goal of ID elimination. Subsequently, several attempts have been made to monitor iodine status of the population. However, they were not successful due to technical problems with UIC analysis.

Beginning from 2015, IGN established an alliance with Georgian NCDC and UNICEF country office to strengthen iodine monitoring and update information on current status of iodine nutrition. IGN supported creation of urinary iodine laboratory in Tbilisi with quality assured UIC analysis. In 2016 IGN assisted NCDC with implementation of a small-scale iodine nutrition assessment in the framework of "Georgia Nutrition Monitoring and Surveillance System" (GNMSS) project funded by US CDC. Results of this assessment showed that median UIC in SAC was 293 µg/L, significantly lower that in 2005. In PW median UIC was 249µg/L. While these results were indicative of optimal iodine nutrition, Georgia NCDC in collaboration with UNICEF and IGN decided to conduct in May-June 2017 a representative countrywide assessment of nutrition status of population (SAC and PW) and use of iodized salt. This survey is needed to provide the most accurate information needed for policy decisions, such as strengthening of monitoring framework and revision on iodine in salt content norms (currently – 40±15mg/kg).

The WHO/UNICEF/IGN [1] recommend monitoring of iodine status in populations by measuring UIC in spot samples and deriving the median UIC. However, this approach does not provide information on the percentage of the population with deficient or excess intakes. For children, the US Institute of Medicine (IOM) recommends calculating the daily iodine intake from spot UICs from the relation between body weight and urine volume [6]. This approach was applied to 2017 Georgia iodine assessment.

In the 2017 Georgia survey nutrient inadequacy of iodine intake was assessed by the Estimated Average Requirement (EAR) cutoff method, using the population distribution of intakes. The percentage of individuals with usual intakes below the EAR are at risk of iodine deficiency, and intake is satisfactory when 97–98% of individuals in the population meet the EAR [7]. This EAR cutoff method was applied in 2017 survey to the distribution of iodine intakes calculated from UIC distributions. However, without accounting for within-person variation, the EAR cutoff method will usually overestimate the prevalence of deficiency. Thus, iodine intakes calculated from the UIC distribution were adjusted for within-person variation. Within-person variation were calculated using repeat UIC samples collection from the same individual in a subset of the study population (roughly 15%), and its effect on the distribution can then be adjusted statistically to more closely resemble the distribution of habitual intakes. The prevalence of iodine deficiency in Georgia was defined as the proportion of the population below the EAR from the adjusted distribution. A similar approach, applied to the upper tail of the UIC distribution, was used to compare intakes with the Tolerable Upper Intake Level (UL) for iodine to estimate the prevalence of excessive intakes [9].

In this study, the raw UIC data in SAC were corrected for individual variation, based on repeat urines in 15% of SAC. As a result, the distribution of adjusted UIC data was less spread out than the raw spot UIC values. Adjusted median UIC in SAC nationwide (298µg/L) was within the range (100-299µg/L) for optimum iodine nutrition of population, albeit close to the upper limit. Median UIC findings in urban SAC were 29µg/L higher than in rural SAC and in the Mountain stratum median UIC was 51µg/L lower than in the General Stratum. Even though these are ample differences, median UIC findings in all the SAC groups are sizably above the threshold for population iodine deficiency.

Of all SAC, 1.8% had iodine intake estimates below their EAR (inadequate intake) and 1.3% had iodine intake estimates above the UL (excessive intake). These findings are lower than the prevalence levels (2.3%) expected in a population with adequate iodine nutrition. The median iodine intake estimate in SAC was 227µg/day. The analysis shows that the iodine intake of Mountain SAC is lower by 43µg/day (19%) than of SAC in the General stratum.

Iodine intake findings support the overall conclusion that successful USI program led to optimal iodine nutrition of Georgia population nationwide. There are no sizable difference in iodine intake between general population and those who reside in the mountain areas of Adjara and Svaneti that historically have been severely iodine deficient. Universally high coverage with quality iodized salt provided sustainable source of iodine in everyday diet to all population of Georgia.

The approach to estimate iodine intakes described above has several limitations. The relation between body weight and daily urine volume was derived from normal-weight United Kingdom children. Although recommended by the US IOM [7], the equation has not been validated in children from different countries or in overweight children; thus, the calculation of daily iodine intakes from spot UIC may be imprecise. This equation needs to be validated in other settings around the world [9].

A salt iodization strategy aims to insert a small amount of iodine into the common diet and provide an additional amount of the essential micronutrient via the daily patterns of food use and consumption in a population. When only iodized salt is available in a country, additional iodine gets consumed together with foods that are manufactured with salt in the recipe (in bread, cheese, and so on) and through the use of iodized salt during meal preparation in the kitchen and meal eating in the households. These two sources of iodine from food salt and household salt combine with the iodine that is naturally present in foods (so-called "native" iodine) to realize the total dietary iodine intake. Together the three dietary iodine sources aim to provide a common iodine intake that meets the biological iodine requirements.

The relationships between UIC levels in SAC (a biomarker for recent iodine intake) and the UNaC and SI values of the same children indicated the existence of a strong dependency of the iodine status (UIC levels) in SAC on the UNaC values in the same urine samples, while the dependency on the SI contents in salt from their households was appreciably weaker. It is of interest to examine the relationship of the iodine intake estimates of SAC (derived from the UIC) with the combination of UNaC and SI values of the same children, and to estimate the relative roles of the dietary iodine intake sources in explaining the iodine nutrition findings of the SAC in the different cohorts (urban, rural and mountain SAC). A convenient technique to analyze how the iodine intake estimates in SAC are dependent on the combination of their UNaC and SI values is called multiple regression. In a simple model of regression analysis, the iodine intake estimates in SAC are treated as the outcome variable that can be explained by the UNaC and SI values of the same children. Because the iodine intake estimates in SAC were not normally distributed, the outcome data (iodine intakes) were transformed into their equivalent logarithmic values.

It should be noted that the findings for the various sources of iodine intake are rather imprecise estimates (i.e., the median values have sizable uncertainty intervals), due to the relatively low numbers of SAC in each group. However, even though the reported findings should be interpreted with caution, they serve as a meaningful illustration of the distributions of the iodine intake sources in the different SAC groups. The overall findings of iodine intake proportions (Native 41%, Food salt 43% and Household salt 16%) are more robust.

The findings of 2017 survey suggest optimal iodine status of PW in Georgia as the median UIC in the 634 PW was 211µg/L, conveniently in the middle of the 150-250µg/L range [10]. The median UIC of the 541 PW who were in the 1st trimester of pregnancy was 211µg/L, which again is similar as for the findings among all the PW. The median UIC in rural and urban PW was 226µg/L and 205µg/L respectively. Given the high dispersion of UIC values which is typical for spot urine collections, these differences are minor.

Universal use of quality iodized salt (both at household level and by food processing industries) played pivotal role in sustainable optimal iodine nutrition of entire population of the country. Only 6.8% of all PW reported the use of iodine supplements at the time of spot urine collection and 25.9% of them used supplements in the past. In PW who stated the use of supplements at the time of urine sampling, the median UIC was 227µg/L - slightly higher that in PW who reported having used iodine supplements in the past (209µg/L) and who reported never having used a supplement (211µg/L). However, these differences are not significant, as typical dispersion of UIC values in spot urine samples does not permit an interpretation based on statistical testing of these differences. Only 0.7% of SAC in the General and 3.4% in the Mountain stratum reported use of iodine supplements.

Iodine deficiency is especially problematic in PW, who have iodine requirement almost twice higher than non-pregnant women because they need to synthesize additional thyroid hormone to cover maternal and fetal needs, and pass iodine to the fetus for fetal thyroid hormone production [10]. Iodine deficiency in utero can cause fetal hypothyroidism and irreversibly impair cognitive development, and data from observational studies in Europe suggest that even mild-to-moderate iodine deficiency during pregnancy can have long-term adverse effects on child cognition. The median UIC in SAC should not be used as proxy to assess iodine nutrition of PW, who should be separately monitored [11].

In 2015, 58% of PW in Europe are covered by national or pooled subnational surveys. In ten countries, iodine intakes are adequate during pregnancy, in 21 countries intakes are deficient, and 23 have no data available (including Georgia). Of European countries that have assessed iodine nutrition during pregnancy, two thirds have reported inadequate iodine intakes even though they can maintain optimal iodine intake in the general population [11].

One of the main challenges of IDD prevention through USI is the need to meet iodine requirements of pregnant women (250µg/day) that is significantly higher than non-pregnant adults (150µg/day). Adequate iodine nutrition in PW is shown by a median UIC between 150 and 499µg/L [10, 11]. In SAC (a proxy to assess iodine nutrition of the general population) a diapason of median UIC indicative of optimal iodine nutrition is 100-300µg/L [12]. Thus, in order to maintain adequate iodine nutrition in PW median UIC in SAC may stay closer to upper limits, but preferably below 300µg/L.

In children, excess dietary iodine has been associated with goiter and thyroid dysfunction. Several recent multicenter studies suggest that the onset of mild thyroid hyperstimulation (as indicated by an increased blood thyroglobulin level) occurs in children when iodine intake increases over 300µg/day), and that goiter begins to appear in children when iodine increased to 500 µg/day [12]. In Georgia median UIC in SAC are below 300µg/L in all cohorts and countrywide.

WHO has repeatedly emphasized that an effective USI program is the best strategy to provide adequate iodine to pregnant women, partly because it ensures thyroidal iodine stores are full in women of reproductive age. In Europe, an increasingly smaller amount of salt is used at the household level (only about 15% of all salt consumed). Thus, for iodized salt programs to be successful, processed foods need to contain iodized salt. Iodization of all food-grade salt is preferable, as in Croatia and Serbia, where iodized salt programs cover the needs of pregnancy [11]. In Belarus, adequate iodine intakes during pregnancy have been achieved thanks to a national strategy that combines mandatory use of iodized salt by the food industry and promotion of iodized table salt directly to consumers [13].

In Georgia all salt that is been used in households and by food processing industry is iodized. Results of the survey indicate that non-iodized salt is not available in the country and more than 90% of salt samples had iodine content above 15mg/kg – universally accepted threshold for quality iodized salt. The successful salt iodization program is the pillar for maintaining sustainable optimal nutrition in Georgia. Where is no need for changing salt iodization levels or for providing exemptions to certain producers that insist on use of non-iodized salt. That will inevitably led to erosion and failure of the extremely successful public health program – elimination of iodine deficiency disorders.

6. RECOMMENDATIONS

6.1. While median UIC in SAC countrywide is close to upper limit, there is no urgent need to alter or reduce current normative levels of salt iodization (40±15mg/kg). Analysis of iodine intakes in SAC showed no evidence of excess iodine consumption in any group (urban, rural, mountain). Moreover, iodine nutrition in PW is perfectly normal with median UIC (211µg/L) conveniently in the middle of recommended values.

6.2. Median SI levels collected from households in all cohorts were very close (in the range of 32-34mg/kg) and perfectly within requirements of Georgia salt standard. Potential decrease of salt iodization normative values even by 10mg/kg (25%) can results in suboptimal iodine intake in some groups of PW and, potentially, in mountain SAC where median UIC was 51µg/L lower than in SAC from the General Stratum. Such move can potentially put at risk entire salt iodization strategy in the country and erode optimal iodine nutrition of entire population.

6.3. Monitoring of iodine nutrition of population, coverage and quality of iodized salt should be continued and strengthened. Currently Georgia has excellent laboratory capacity for performing quality assured analysis of iodine in urine. GNMSS (Georgia Nutrition Monitoring and Surveillance System) should continue to monitor iodine nutrition (as well as status of other micronutrients) on annual basis. A test run of iodine assessment in the framework of GNMSS in 2016 showed that median UIC in 91 SAC (293 µg/L) was practically the same as in 847 SAC assessed during 2017 survey (298 µg/L). Median UIC in 47 PW assessed in 2016 was 249µg/L, only slightly higher than in 643 PW in 2017 - 211µg/L. Because of universal coverage of population with quality iodized salt, GNMSS can provide extremely accurate estimation of iodine nutrition at a small fraction of costs of the national iodine survey.

6.4. Health professionals (endocrinologists, OBG, pediatricians, general practitioner, etc.) should be discouraged to recommend iodine supplement to PW and SAC without strong suspicion of inadequate iodine intake (such as veganism or extremely low salt consumption for medical or behavioral reasons). Already only relatively small number of PW (6.8%) and insignificant (from 0.7% to 3.4%) proportion of SAC used iodine supplements at the time of the assessment.

6.5. Results of 2017 Georgia iodine survey should be published in national and international medical journals and presented on the meetings. Balanced and scientifically correct information should be provided to general public through the media.

7. LITERATURE

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ANNEX 1.
Data collection instruction

Day 1. Selection of schoolchildren for the survey

1. The research specialist goes to selected school (cluster) and brings screw cupped 60 ml vials for collection of urine and salt, questionnaires (Form #1), and informed consent forms (Form #3) for parents of selected children. All these vials and forms will be pre-labeled: the label should include cluster and individual number of the child. The research specialist will know the number/sequence of the student and will identify the child in the grade book according to his/her number; if assessment of the selected child is impossible, the next child in the list will be surveyed.

2. The research specialist explains teachers and parents what **Informed Consent Form (Form 3)** is about. The survey team will collect samples of salt from households and samples of urine from schoolchildren. This does not pose any risk to schoolchildren, or to anybody else. Parents must sign this Form and return in back with sample of salt from their households with completed **Questionnaire (Form #1)**.

3. <u>Collection of salt samples</u>: instruct children/parents to fill in provided 60 ml vial with salt that is been used in the household. <u>If two types of salt are used (for example – coarse salt in kitchen and fine Extra grade salt at the table), instruct to parents to provide kitchen salt.</u>

4. <u>Collection of urinary samples</u>: instruct children to collect morning urine sample by urinating directly into the provided screw cupped 60 ml vial. Inform the children that they need to fill the cap approximately <u>half full</u>. Tightly screw the cup of the vial and bring it to school together with sample of salt, completed questionnaire and signed informed consent form.

Day 2. Collection of salt and urine samples

1. Research specialist will complete the **School Data Collecting Form** (**Form 2**) based on listing obtained after initial selection of schoolchildren. Insert names, age and sex of all children participating in the survey. If some of earlier selected children are missing, random select additional children aged 6-12 years. Children who are taking iodine supplements (check relevant answer in Questionnaire) should be excluded and replaced by other randomly selected children. **The School Data Collecting Form** must have a **Cluster Number** assigned by Principal Investigator.

2. Measure the body weight of each child in whole kg using platform scale. Write a number assigned to each child in Form #2.

3. Collect 60 ml vials with salt and urines, as well as questionnaires and informed consent forms brought by children from homes. If urine sample is missing, be prepared to collect urine sample in school. Place salt and urine samples in two separate transportation boxes and bring them together with questionnaires and consent forms to regional NCDC unit. Keep samples in cool place before transporting to central collection base in Tbilisi.

3. At the end of collection process, the research specialist should review the information on School Data Collection Form (Form 2) to assure that it is complete and appears to be correct. This should be performed before leaving the school (while children are present) so that incomplete or incorrect information can be verified or corrected. If some of selected children are taking iodine supplements or multivitamins with iodine, select another child by repetition procedures for Day 1.

Day 3. Collection of repeat urine samples

On the last day of the assessment research specialist is returning back to school for repeat urine collection. Instructions for random selection of SAC for repeat urine selection will be provded. When labeling repeat urine samples, be sure to put the same child number as was assigned on the previous day and add **X** (for example: – sample #5 should be labeled **5X**). Upon return back to the base, place repeat samples urine samples together with other samples collected at the same school the day before.

Central collection base

"Test-Diagnostika" laboratory will be central collection base for urine sample collected during the survey. Upon receipt of 60 ml collection vials from regional NCDC units, laboratory technician will record samples in special form, and aliquot them in 3 (three) 1.5-3 ml Eppendorf vials (one - for UIC, second - for UNaC and third – reserve sample). This urine samples will be kept refrigerated until laboratory analysis has been performed.

ANNEX 2.
Urinary iodine analysis

The procedure for determining iodine in urine by Ammonium Persulfate Digestion with Spectrophotometric Detection

Chemicals and Standards Water, high purity (≥18 MΩ·cm resistivity)

Ammonium peroxydisulfate (NH4)2 S2 O8 . cat.N **A3678** Sigma-aldrich

Arsenic trioxide (As2 O3). Cat.N **311383** Sigma-aldrich

Sodium chloride (NaCl). Cat.N **S7653** Sigma-aldrich

Concentrated sulfuric acid (H2 SO4). Cat N 7664-93-9 Loba Cemie

Ceric ammonium sulfate dihydrate (NH4)4 Ce (SO4)4 2H2 O. Cat N **383090** Sigma-aldrich

Stock solution of iodine: CRM - ion chromatography 1000 mg/L iodide in H2 O

Catalog Number: ICI1-1 and ICI1-5, or a supplier of your own preference.

Potassium iodate (KIO3). Cat N **438464** Sigma-aldrich

Reagent Preparation

1. Ammonium persulfate. Dissolve 228.2 g of ammonium peroxydisulfate ((NH4)2 S2 O8) in 1L of 18 MΩ·cm resistivity water. Store in darkness. Keep refrigerated to prevent decomposition (4-10ºC).
2. Arsenious acid. Place 5 g arsenic trioxide (As2 O3) and 25 g sodium chloride (NaCl) in a clean 1L volumetric flask, and then add 200 mL 5N sulfuric acid (H2 SO4). Add about 300 mL of 18 MΩ·cm resistivity water, heat gently, stir to dissolve, and then cool to room temperature. Dilute with 18 MΩ·cm resistivity water to 1L. Store in darkness. Solution will remain stable for 6 months.
3. Ceric ammonium sulfate solution. Dissolve 24 g ceric ammonium sulfate dihydrate (NH Ce (SO4 4)4)4 .2H2 O in 1L of 3.5N sulfuric acid. Make up at least 24 hours before use. Store at room temperature in darkness and solution will remain stable for 6 months.
4. 5N Sulfuric acid (1L). For safety reasons, prepare in an ice-water bath. Slowly add 139 mL concentrated sulfuric acid into a 1-L volumetric polypropylene flask containing about 500 mL of 18 MΩ·cm resistivity water. Dilute to 1L with 18 MΩ·cm resistivity water. Store in a PP bottle at room temperature and prepare as needed.
5. 3.5N Sulfuric acid (1L). For safety reasons, prepare in an ice-water bath. Slowly add 97 mL concentrated sulfuric acid into a 1-L volumetric VPP flask containing about 500 mL of 18 MΩ·cm resistivity water. Dilute to 1L with 18 MΩ·cm resistivity water. Store in a PP bottle at room temperature and prepare as needed.

Standards Preparation Stock Solution of Iodine CRM - ion chromatography 1000 mg/L Iodide in H2 O

Intermediate Standards Preparation Add 9 mL of 18 MΩ·cm resistivity water to an acid-rinsed 50 mL tube and then add 1 mL of 1000 mg/L stock standard. Mix well. Store in acid-washed, labeled 50 mL PP tube at room temperature and prepare a fresh set of standards every 6 months. working Standards Preparation Double rinse each flask or tube vigorously with 5% v/v nitric acid followed by a double rinse with 18 MΩ·cm resistivity water. Fill each with 5% v/v nitric acid and allow them to soak for several hours or overnight. Follow with rigorous rinsing of each with 18 MΩ·cm resistivity water. Fill six labeled, acid-washed 100 mL volumetric flasks with approximately 90 mL of 18 MΩ·cm resistivity water each. Spike each flask with the appropriate volume of the Intermediate Stock Standards Solutions

Dilute to 100 mL with 18 MΩ·cm resistivity water. Store in acid-washed, labeled, 50 mL PP tube at room temperature and prepare a fresh set of standards every 6 months. Pour out small amounts of each calibrator into separate, clean 15 mL PP tubes for daily use in preparing working standards.

Graphing software, such as Excel, may be used to construct a standard curve. To create the scatter-plot graph, the log of the absorbance (Abs) at 405 nm is plotted on the y-axis against the standard iodine concentration in µg/L on the x-axis. The equation obtained from the linear trend line of the graph may be used to calculate iodine concentrations of each specimen. Because this is an inverse endpoint reaction, a 1:3 or 1:5 dilution should performed on the specimens with absorbance values lower than the acceptable standard curve or that calculate concentration >300 µg/L. Ordinary absorbance values range between 0.300 and 1.800 for standards with concentrations between 300 µg/L and 0 µg/L.

Procedures

Allow urine and QC specimens to reach ambient temperature. Vortex the sample well so that no particulates remain on the bottom of the tube before taking an aliquot for analysis. Pipette 250 µL of each urine sample, working standards and bench QC into a 13 x 100-mm test tube. Pipette all samples in duplicate. Add 1 mL of ammonium persulfate solution to each tube. Mix and heat all tubes on a heating block for 60 minutes at 91°- 95°C (digestion step). After digestion, cool tubes to room temperature. Add 3.5 mL of arsenious acid solution. Mix and let stand for 15 minutes. Add 400 µL of ceric ammonium sulfate solution to each tube and quickly mix by vortex or other means (A timer should be used to keep a constant interval of 30 seconds between additions to successive tubes.) Exactly 30 minutes after the addition of ceric ammonium sulfate to the first tube, read its absorbance at 420 nm in a spectrophotometer. Read successive tubes at the same time intervals as when adding the ceric ammonium sulfate.

Each analysis was performed intralaboratory control. As a control used the NIST 2670 with a known concentration of iodine (84-92 µ g/L prepared for inter-laboratory control). The obtained results are presented in the table below.

Intralaboratory control NIST 2670

N of studies	Total number of tests	Control Result 1	Control Result 2	Control Result 3	Control Result 4	Control Result 5
1	97	88,1	84,4	84,1	84,7	84,5
2	97	84,4	86,1	86,4	86,8	87,3
3	97	85,7	90,7	87,1	86,2	87,5
4	97	84,5	85,5	85,8	84,5	87,6
5	97	89,5	84,8	84,8	90,2	92,8
6	97	84,7	87,6	89,3	89,1	89,2
7	97	86,2	89,3	91,5	85,2	87,2
8	97	84,3	86,1	85,7	88,9	87,4
9	97	84,8	88,5	90,1	84,8	87,6
10	97	87,3	84,6	83,9	92,7	90,8
11	97	85,0	85,0	85,0	91,6	89,1
12	97	85,7	89,4	88,0	86,7	86,3
13	97	90,5	84,8	84,7	88	85,6
14	97	84,5	87,4	85,5	87,4	84,5
15	97	90,3	85,6	84,3	84,9	85,6
16	97	84,4	86,2	87,1	84,5	90,6
17	97	84,4	90,7	88,7	87,9	87,0
18	97	84,4	84,4	85,5	85,3	87,3
19	97	84,3	85,4	86,5	84,5	86,4
20	97	85,3	86,2	84,5	84,5	84,4
21	97	87,3	84,9	86,5	86,5	
22	71	84,5	90,5	88,1	85,3	

NIST 2670 included in the research through the analysis every 20 to 25 samples

M.D. /Ph.D. Nelly Barnabishvili
Test Diagnostics Ltd
61 Tsintsadze str.
Tbilisi 0 060
Georgia(Caucasus)
Tel/Fax: 99532 2109108Tel: 995599 312445;
E-mail: nelibarnabishvili@eurolab.ge, barnabishvili2013@yandex.ru

ANNEX 3. Survey questionnaires

Number __ __ __ __ [IDN]

QUESTIONNAIRE FOR PARENTS OF SCHOOL-AGED CHILDREN (WITH CODES)

1. Family and name of the child ______________________________ [K1Name]

2. Address _________________________ [K2Address]   3. Age _____________(full years) [K3Age]

4. Where do you reside? [K4Urbanrural]

Rural place	1
Urban place	2

5. Do you know about existence of iodized salt? [K5saltinformation]

Yes	1
No	2

6. What salt do you usually use at home? [K6Saltused]

Iodized	1
Not iodized	2
Don't know	3

7. In what packaging do you usually buy salt? [K7RogorSepuTviTyidulobT]

industrially produced poly (paper) bag with labeling	1
poly (paper) bag without labeling	2
loose salt	3
do not buy salt	4

8. Salt producer (write the name from the salt package) __________________________ [K8Saltproduser]

9. Did your child take any iodine supplement (such as Jodomarine™, Jodbalance™, potassium iodide) in the past 3 months? [K9Iodineuse]

Took before	1
Taking now	2
Never took	3 - MOVE TO 11

10. If took, who prescribed the supplement [K10 VisirekomendaciiT]

Pediatrician	1
Endocrinologist	2
Other physician	3
Own initiative	4

11. What are the benefits of iodine?

(Ask question and mark typical answer – could be more than one)

		MARKED YES	MARKED NO
Prevents goiter	[K111Goiterprevention]	1	2
Important for mental development	[K112mentaldevelopment]	1	2
Beneficial for fetus development	[K113fetusdevelopment]	1	2
All the above	[K114everything]	1	2
Other (write in ____________________)	[K115Other]	1	2
Don't know	[K116DK]	1	2

12. Somebody in the family have thyroid disorder? [K12Familythyroidi]

Yes	1
No	2
Don't know	3

13 Weight of the child ____________ (write in) [K13Weight]

Number __ __ __ __ [IDN]

QUESTIONNAIRE FOR PREGNANT WOMEN

1.Last and first name ________________________________ [KNAME]

2. Address__________ [KAddress] 3. Age __________(full years) [KAge]

4. Residence [Kurbanrural]

Rural place	1
Urban place	2

5. Month of gestation (write number)__________ [Kgestation]

6. Number of pregnancies (write number)____________ [K6pregnancies]

7. Did you have thyroid disorders before pregnancy [K7thyroid]

Yes	1
No	2
Don't know	3

8. Do you know about existence of iodized salt? [K8saltknowledge]

Yes	1
No	2

9. What salt do you use at home? [K9saltuse]

Iodized	1
Not iodized	2
don't know	3

10. In what packaging do you usually buy salt? [K10saltpack]

industrially produced poly (paper) bag with labeling	1
poly (paper) bag without labeling	2
loose salt	3
do not buy salt	4

11. Did you take any iodine supplement (such as Jodomarine™, Jodbalance™, potassium iodide) in the past 3 months? [K11Iodineuse]

Took before	1
Taking now	2
Never took	3 - MOVE TO 13

12. If taken, who prescribed the supplement [K12prescriptor]

OBG	1
Endocrinologist	2
Other physician	3
Own initiative	4

13. What are the benefits of iodine?

(Ask question and mark typical answer – could be more than one)

			MARKED	
			YES	**NO**
Prevents goiter [K131Goiterprevention]			**1**	**2**
Important for mental development [K132mentaldevelopment]			1	2
Beneficial for fetus development [K133fetusdevelopment]			**1**	**2**
All the above	[K134everything]	1	2	
Other (write in ________________)	[K135Other] [K135text		1	2
Don't know	[K136DK]		1	2

14. Somebody in the family have thyroid disorder? [K14thyroidproblems]

Yes	1
No	2
Don't know	3

15. Do you smoke now or smoked before pregnancy? [K15smoking]

Yes	1
No	2

ANNEX 4.
Results of KAP survey
of SAC parents and PW in Georgia

Table 1. Questionnaire responses by parents of SAC from General (rural and urban areas) and Mountain strata

---

4. Where do you reside?

General stratum			
	Urban population		67.4%
	Rural population		21.6%
Mountain stratum			
	Urban population		4.7%
	Rural population		95.3%

5. Did you know about existence of iodized salt?

General stratum			
	Urban population		Yes – 93.3%, No – 6.7%
	Rural population		Yes – 87.0%, No – 13.0%
	All		Yes – 91.6% No – 8.4%
Mountain stratum			
	Adjara		Yes – 84.5%, No – 15.5%
	Svaneti		Yes – 98.6%, No – 1.4%
	All		Yes – 87.5%, No – 12.5%

6. What salt do you usually use at home?

General stratum			
	Urban population		
		Iodized	61.5%
		Not iodized	12.4%
		Don't know	26.2%
	Rural population		
		Iodized	46%
		Not iodized	17%
		Don't know	37%
	All		
		Iodized	57.0%
		Not iodized	13.7%
		Don't know	29.3%
Mountain stratum			
	Adjara		
		Iodized	26%
		Not iodized	16.4%
		Don't know	57.7%

Svaneti		
	Iodized	67.1%
	Not iodized	15.7%
	Don't know	17.2%
All		
	Iodized	34.7%
	Not iodized	16.2%
	Don't know	49.1%

7. In what packaging do you usually buy salt?

General stratum

Urban population		
	Industrial	80.7%
	No label	9.2%
	Loose	10.1%
	No salt	0%
Rural population		
	Industrial	73.2%
	No label	10.7%
	Loose	15.6%
	No salt	0.5%
All		
	Industrial	78.6%
	No label	9.6%
	Loose	11.7%
	No salt	0.1%

Mountain stratum

Adjara		
	Industrial	75.2%
	No label	17.7%
	Loose	7.1%
Svaneti		
	Industrial	90.3%
	No label	2.8%
	Loose	6.9%
All		
	Industrial	78.5%
	No label	14.4%
	Loose	7.1%

8. Salt producer

Information on market share and salt iodine content by producer origin is presented in section 4.2.3 of the report.

9. Did your child take any iodine supplement (such as Jodomarine™, Jodbalance™, potassium iodide) in the past 3 months?

General stratum			
	Urban population		
		Took before	13.3%
		Taking now	5.1%
		Never took	86.1%
	Rural population		
		Took before	5.1%
		Taking now	0.7%
		Never took	94.3%
	All		
		Took before	10.9%
		Taking now	0.7%
		Never took	88.5%
Mountain stratum			
	Adjara		
		Took before	14.1%
		Taking now	4.3%
		Never took	81.6%
	Svaneti		
		Took before	11.1%
		Taking now	0.0%
		Never took	88.9%
	All		
		Took before	13.4%
		Taking now	3.4%
		Never took	83.2%

10. If took, who prescribed the supplement?

General stratum (99 SAC with previous and current supplement use)		
	Pediatrician	52%
	Endocrinologist	25.6%
	Other physician	1.4%
	Own initiative	21%
Mountain stratum (48 SAC with previous and current supplement use)		
	Pediatrician	12.5%
	Endocrinologist	0.0%
	Other physician	0.0%
	Own initiative	87.5%

11. What are the benefits of iodine? (Multiple answers

General stratum

Prevents goiter	54.2%
Important for mental development	31.9%
Beneficial for fetus development	29%
All the above	45.2%
Other	2.6%
Don't know	7.3%

Mountain stratum

Prevents goiter	57.24%
Important for mental development	35.8%
Beneficial for fetus development	31.3%
All the above	48.9%
Other	2.4%
Don't know	5.8%

12. Somebody in the family have thyroid disorder?

General stratum

Urban population		
	Yes	25.6%
	No	63.2%
	Don't know	11.2%
Rural population		
	Yes	22.6%
	No	55.9%
	Don't know	21.5%
All		
	Yes	24.7%
	No	61.1%
	Don't know	14.1%

Mountain stratum

Adjara		
	Yes	14.0%
	No	42.9%
	Don't know	42.1%
Svaneti		
	Yes	25.4%
	No	45.1%
	Don't know	29.5%
All		
	Yes	17.2%
	No	43.4%
	Don't know	39.4%

Table 2. Questionnaire responses by PW

7. Did you have thyroid disorders before pregnancy		
	Yes	12.5%
	No	75.5%
	Don't know/No answer	12.0%
8. Do you know about existence of iodized salt?		
	Yes	81.0%
	No	18.6%
	Don't know/No answer	0.4%
9. What salt do you use at home?		
	Iodized	36.8%
	Not iodized	30.9%
	Don't know/No answer	32.3%
10. In what packaging do you usually buy salt?		
	industrially produced poly (paper) bag with labeling	71.9%
	poly (paper) bag without labeling	11.9%
	loose salt	12.2%
	do not buy salt	2.0%
	Don't know/No answer	2.0%
11. Did you take any iodine supplement (such as Jodomarine™, Jodbalance™, potassium iodide) in the past 3 months?		
	Took before	25.9%
	Taking now	6.8%
	Never took	65%
	Don't know/No answer	2.3%
12. If taken, who prescribed the supplement		
	OBG	3.2%
	Endocrinologist	34.1%
	Other physician	54.4%
	Own initiative	4.1%
	Don't know/No answer	4.2%
14. Somebody in the family have thyroid disorder?		
	Yes	18.1%
	No	70.3%
	Don't know/No answer	11.6%
15. Do you smoke now or smoked before pregnancy?		
	Yes	5.6%
	No	93.5%
	Don't know/No answer	0.9%

ANNEX 5.
Analysis of UNaC data in SAC

1. Data treatment

Raw UNaC data were corrected for individual variability, using repeat urine collections from 192 SAC.

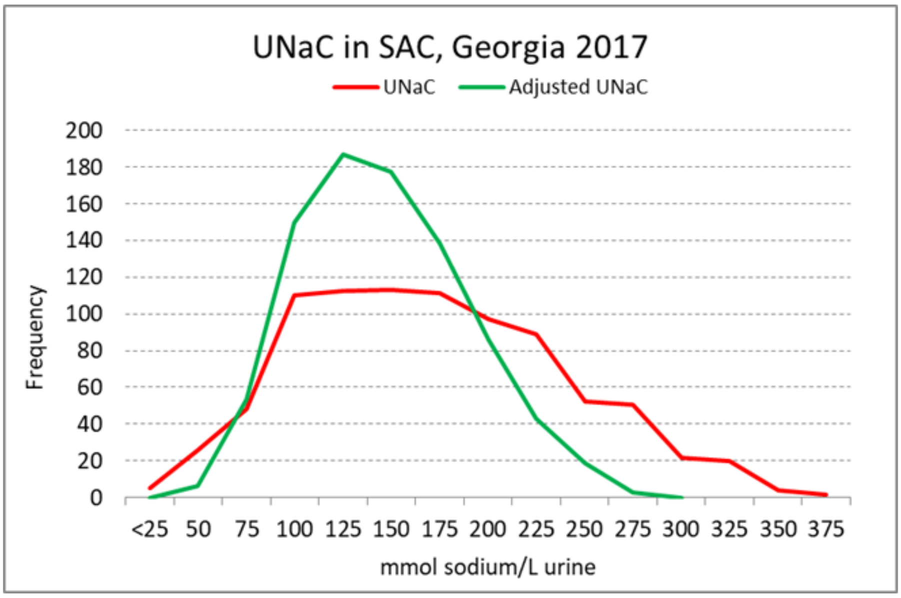
Source of Variation	Variance	SD	**SD Ratio Between/Total**
Within SAC	2,658.15		(Within variation = 61% of total variation)
Between SAC	1,733.25	41.63	**0.628**
Total	4,391.40	66.27	

Using the SD ratio, UNaC values for each SAC were corrected with the IOM formula[1]

Adjusted UNaC = [(person's UNaC – group mean)*SD ratio] + group mean

2. General SAC survey

UNaC data were available for 863 SAC, i.e., coverage of 95.9%. The statistical analyses are weighed by urban/rural location within regions for missing data.



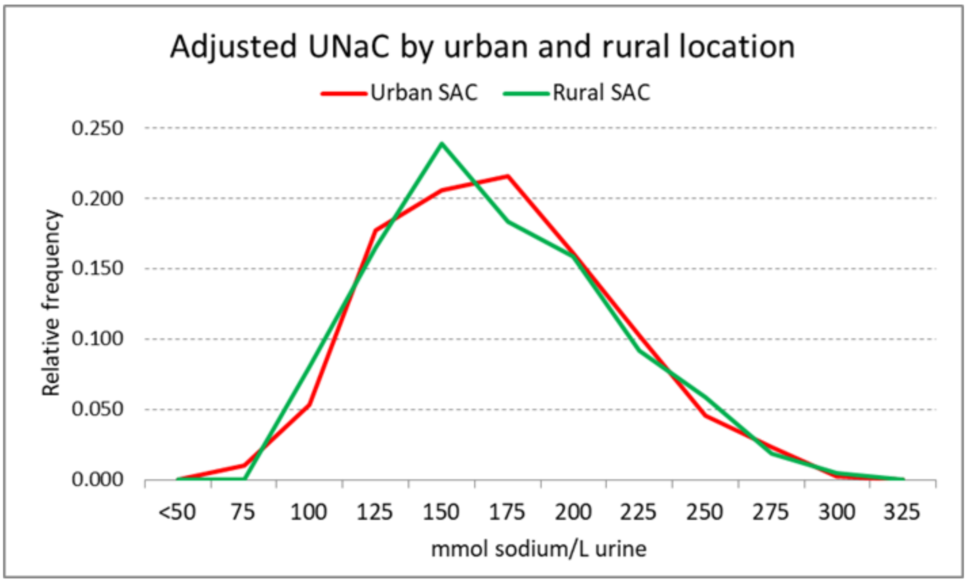
1 Institute of Medicine, Subcommittee on Interpretation and Uses of Dietary Reference Intakes, 2003. Dietary Reference Intakes. Applications in dietary planning. Washington DC, National Academies Press. Appendix E: Adjustment of observed intake data to estimate the distribution of usual intakes in a group, pp 196-208. Available at http://nationalacademies.org/hmd/Reports/2003/Dietary-Reference-Intakes-Applications-in-Dietary-Planning.aspx

UNaC distribution characteristics, with and without adjustment for within-person variability in grade III-IV SAC, Georgia 2017

	Raw UNaC values from spot urine collections	UNaC values adjusted for within-person variability
Mean	158	159
SD	67.4	42.3
Percentiles		
25th	107	127
50th	153	155
75th	205	188

Figure 1 and Table 1 show that the distribution of adjusted UNaC values is less dispersed than of the raw spot UNaC data. Adjusted UNaC values are used for further data processing.

a. Findings by urban/rural area



Adjusted UNaC by urban and rural location

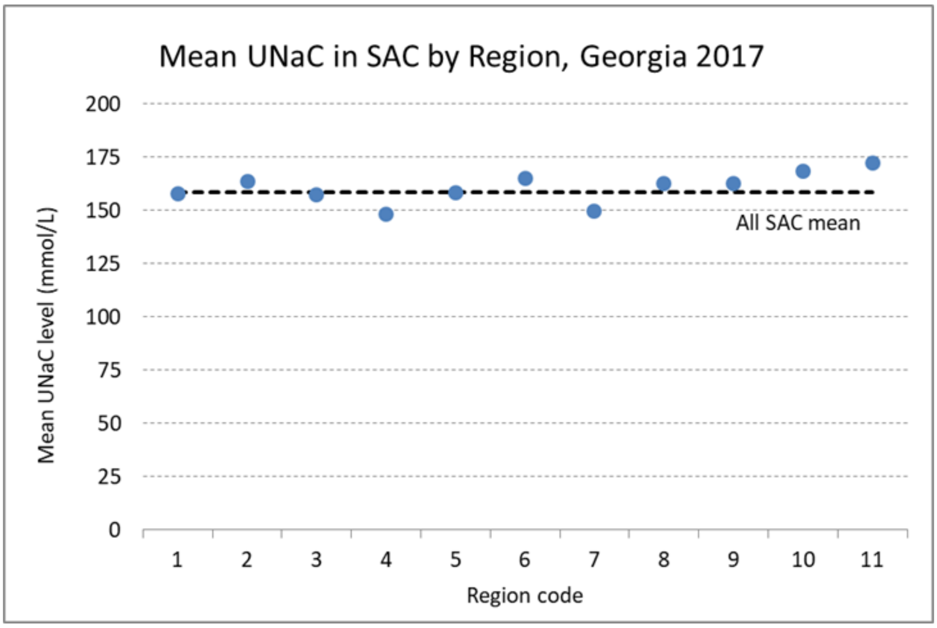
Location	N	Mean	SD	95% CI	
Urban	589	159	42.0	155 to 162	No difference in UNaC
Rural	274	158	43.1	153 to 163	between urban and rural SAC
All SAC	863	159	42.3	156 to 161	

b. Findings by region

Adjusted UNaC in SAC by region

Region code	N	Mean	SD	95% CI	
1	82	158	39.7	149	to 166
2	300	164	42.8	159	to 168
3	66	157	42.6	147	to 168
4	108	148	40.7	140	to 156
5	65	158	38.5	149	to 168
6	53	165	40.3	154	to 176
7	109	150	45.7	141	to 158
8	21	163	33.2	147	to 178
9	37	163	47.5	147	to 179
10	18	169	39.1	149	to 188
11	4	172	45.9	73	to 272
All SAC	863	159	42.3	156	to 161

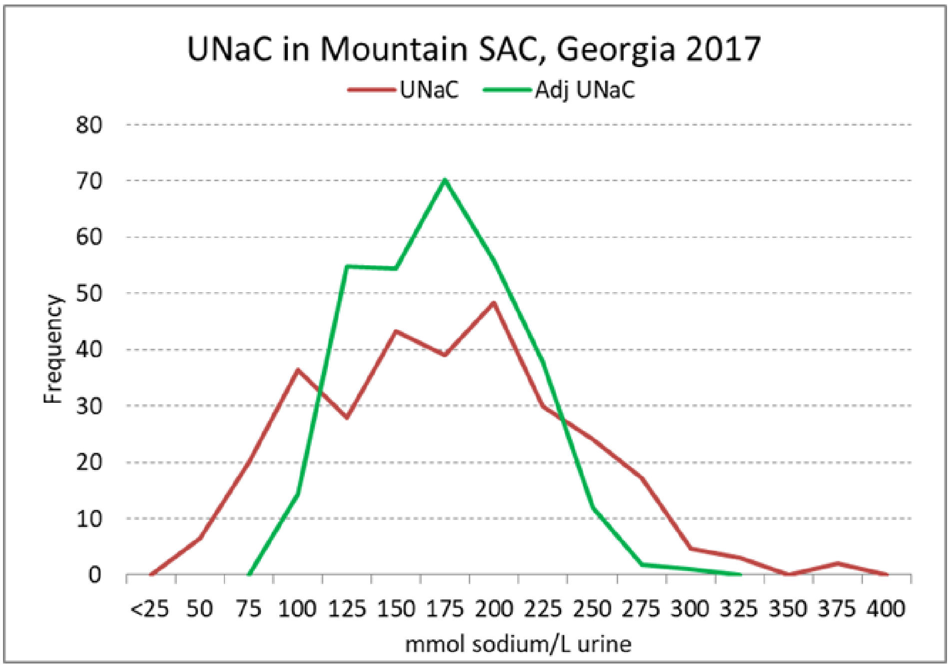
Across regions, the lowest UNaC in SAC (148mmol/L) was found in region 4 (Imereti), while the SAC in region 10 (Mtskheta-Mtianeti) and region 11 (Racha-Lechkhumi and Kvemo Svaneti) had the highest UNaC levels (169 and 172mmol/L, respectively).



3. Mountain survey

From the Mountain survey, UNaC values were available of 302 SAC, i.e., 93.2% coverage. The statistical analyses were weighted by clusters within strata for missing data.

a. Findings of UNaC and adjusted UNaC in Mountain SAC



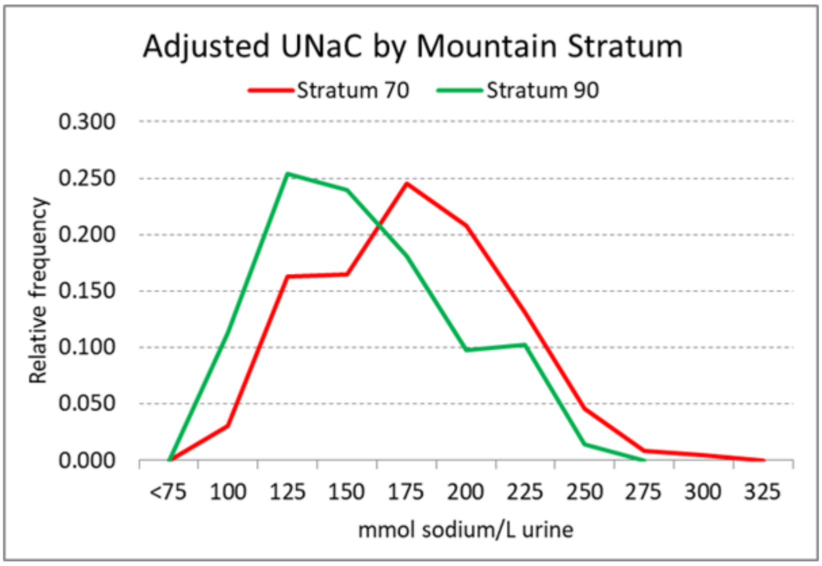
UNaC distribution characteristics, with and without adjustment for within-person variability in grade III-IV SAC, Mountain survey, Georgia 2017

	Raw UNaC values from spot urine collections	UNaC values adjusted for within-person variability
Mean	160	160
SD	63.2	39.7
Percentiles		
25th	112	130
50th	158	159
75th	204	187

Similar as for the general survey, the distribution of adjusted UNaC values of SAC in the mountain survey is less spread out than the raw spot UNaC data. Adjusted UNaC values were used for further data processing.

b. **Findings by Mountain stratum**

The mountain survey was conducted in two selected regions of Georgia, namely Adjara (stratum code 70) and Svaneti, Racha (stratum code 90).



Adjusted UNaC in SAC by Mountain stratum

Stratum	N	Mean	SD	95% CI	
70	239	164	38.8	159	to 169
90	63	144	39.1	134	to 154
All Mountain SAC	302	160	39.7	156	to 165

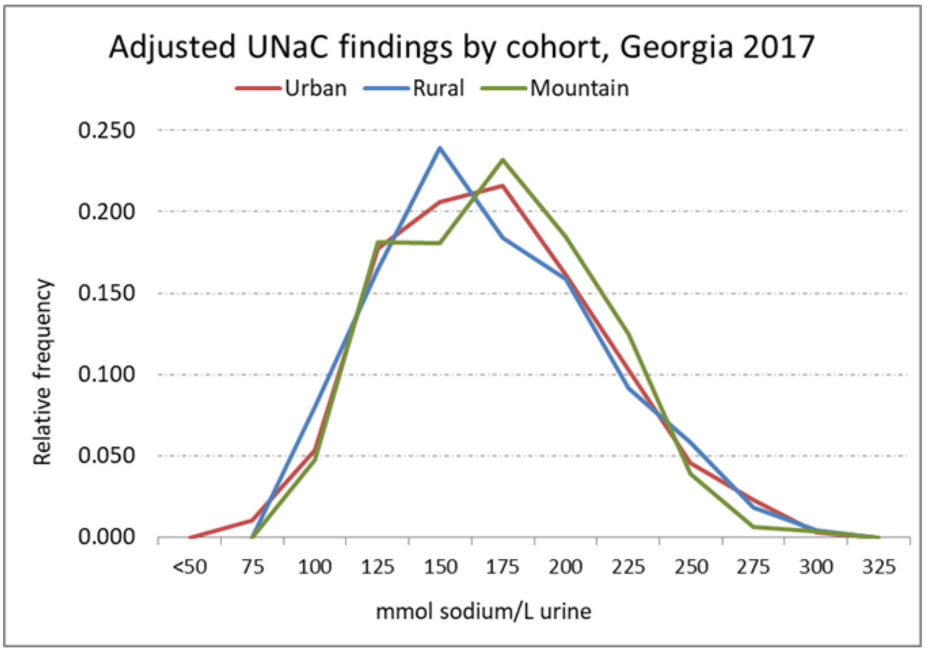
UNaC findings of SAC in mountainous Svaneti (144mmol/L) are lower (*P*<0.001) than in Adjara (164mmol/L).

4. Comparison between the general survey and the mountain survey

Adjusted UNaC findings by survey cohorts

Location	N	Mean	SD	95% CI	
General survey					
Urban cohort	589	159	42.0	155	to 162
Rural cohort	274	158	43.1	153	to 163
Mountain cohort	302	160	39.7	156	to 165

As shown in the Table above and the Figure below, the UNaC findings in SAC across the various cohorts are similar.



ANNEX 6.
Illustration of the procedure to apportion the sources of dietary iodine (I2) intake in rural SAC

The rising line in the Figure below portrays the main association between the iodine intake and UNaC values, adjusted for the SI content variable. Marker symbols on the ordinate (Y axis) indicate the iodine intake values obtained from back-transformation of the logarithmic findings of the regression, that is, **iodine intake - e^z**, in which the *z* values are calculated in three steps with use of regression parameters. In sequence, the steps proceed as follows:

(1) The start-out *z* value equals the intercept estimate for rural SAC, that is, *z* = 4327. Then, the back-transformed value for iodine intake is $e^{4.327}$ = 79 µg/day (indicated by the round symbol on the ordinate). This finding is interpreted as the part iodine intake in rural SAC that corresponds with native dietary iodine intake

(2) In the 2nd step, *z* is calculated with the regression parameter of UNaC and the average UNaC finding in rural SAC (mean UNaC = 160mmol/L). Then, *z* = 4.327 + 0.0043 x 160 = 5.015 and $e^{5.015}$ = 157µg/day (the triangular symbol). The fraction of iodine intake from food salt in rural SAC is obtained as the increment above the step (1) result, that is, iodine intake = 157 – 79 = 78µg/day

(3) The 3rd step uses the total median iodine intake in rural SAC (square symbol = 215µg/day), and obtains the increment above the result of step (2): iodine intake = 215 – 157 = 58µg/day. This finding is interpreted as the iodine intake part in rural SAC that corresponds with iodine intake from household salt.