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Guidance on the Monitoring of Salt Iodization Programmes and Determination of Population Iodine Status

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Contents

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Introduction

There has been remarkable progress towards eliminating iodine deficiency disorders (IDD) over the past two decades. Since 1990, the number of countries classified with iodine deficiency has declined from 113 to 20 (1). This progress is due, primarily, to the scale up of salt iodization programmes. Current methods and practices have supported this remarkable progress. However, important lessons have emerged in recent years on how to better track and refine salt iodization programmes.

This document presents such lessons, as identified during a Technical Consultation on the Monitoring of Salt Iodization Programmes held at UNICEF Headquarters in December 2015 (2). The purpose of this document is to guide programme managers in avoiding common mistakes made in the interpretation of data and implementation of national IDD control programmes. Some of the lessons discussed in this document reinforce key recommendations made in the 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers: Assessment of iodine deficiency disorders and monitoring their elimination (3rd Edition), which remains a valuable resource for programme managers (3). In addition, the current document presents new information and updates not contained in the 2007 WHO/UNICEF/ICCIDD Guide; this information may be considered in future versions of the Guide.

The intended users of this document are managers of national IDD control programmes. It is hoped that the information presented in this document will enable those managers to improve the effectiveness of the programmes they support.

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Changing context of salt iodization and iodine nutrition programmes

The concept of universal salt iodization entails the iodization of all food-grade salt (i.e. salt used in both households and during food processing) (4). However, programme efforts in many countries have been limited to ensuring that only household salt is adequately iodized. Given that the consumption of salt through processed foods[1] is increasing in many settings, the salt contained in such foods is an important potential source of dietary iodine and should therefore be monitored by programme managers (5–7). At the same time, programme managers should consider the growing importance of reducing salt intake to prevent non-communicable diseases. This changing context highlights the need for alignment between the implementation and monitoring of salt iodization strategies and salt reduction strategies (4). Salt iodization remains the main strategy for achieving sustained IDD control, and global experience has demonstrated that the iodization of food grade salt is the most equitable, effective and sustainable strategy to ensure optimal iodine nutrition for all population groups.

1 In this document, the term 'processed foods' refers to large-scale, commercially produced and manufactured foods, including bread, instant noodles, bouillon and other salty condiments.

Summary of key recommendations

This document highlights the following key recommendations:

1. **As resources allow, the adequacy of iodine intakes should be examined among different subsets of the population, especially among groups vulnerable to deficiency.** National-level median urinary iodine concentrations (mUIC) may hide discrepancies in iodine intake among different sub-groups, such as those defined by geographic region or residence, socio-economic status, or programmatically relevant criteria (e.g., by sources of salt, packaged/unpackaged salt). Such stratified analyses may help identify remaining challenges and inform adjustments to salt iodization programmes.

2. **Rapid test kits (RTKs) should only be used to differentiate between non-iodized and iodized salt.** RTKs can accurately distinguish between iodized and non-iodized salt. However, the ability of RTKs to measure the iodine content in quantitative terms and to distinguish between iodine content in salt below and above certain cutoff levels is questionable (even when the RTK packaging suggests otherwise) (8–10). Given this limitation, RTKs should only be used to measure the percentage of salt that contains any iodine at all. More precise methods, such as titration or other validated quantitative assessment tools are required to measure the percentage of salt that is inadequately iodized or adequately iodized (11).

3. **The acceptable range of 'adequate' iodine intake among school-age children can be widened from 100–199 µg/L to 100–299 µg/L.** According to the 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers (3), a mUIC in the range 100–199 µg/L indicates 'adequate' iodine intake and the range of 200–299 µg/L indicates 'more than adequate' iodine intake

among school-age children. The presence of a mUIC in the 'more than adequate' range has raised concerns about the potentially adverse effects of high iodine intake on normal thyroid function. However, a 2013 study assessing thyroid function and iodine status found that the mUIC range of 100–299 μg/L was not associated with any thyroid dysfunction (12). As a result, the acceptable range of 'adequate' iodine intake among school-age children can be widened to 100–299 μg/L. There is no data to indicate, however, that this widened range can be applied to other groups such as women of reproductive age. The interpretation of a mUIC of ≥ 300 μg/L as 'excessive iodine intake' remains unchanged.

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4. **With currently available methods, the mUIC can only be used to define population iodine status and not to quantify the proportion of the population with iodine deficiency or iodine excess.** As an example, a mUIC of 122 μg/L obtained from a survey among school-age children identifies a population that has no iodine deficiency. While a proportion of children in that survey would have UIC values of < 100 μg/L, it would be incorrect to label that percentage of children as 'deficient'. Likewise, those children in the population with UIC scores of ≥300 μg/L cannot be labeled as the proportion of children with 'excessive' iodine intakes. However, as recommended in the 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers, not more than 20% of samples should be < 50 μg/L (3).

5. **National salt iodization programmes should monitor the use of iodized salt in processed foods.** Household- and school-based surveys measuring iodine content in household salt have been an important monitoring tool for assessing the performance of salt iodization programmes. While iodine in the diet was previously assumed to come predominantly from household iodized salt, recent evidence suggests that an increasing amount of iodized salt is consumed through processed foods (5–7, 13) in different settings. If the salt contained in such foods is well iodized, it can be an important source of iodine and may help explain iodine sufficiency in settings where household iodized salt coverage is low (14). Programme managers should therefore evaluate whether major processed foods are manufactured with iodized salt. In selected cases, the iodine contained in water may also need to be assessed.

Use of data to evaluate programme effectiveness

National surveys provide important data on key indicators of salt iodization and iodine status. However, data from national surveys should be interpreted in conjunction with complementary data that: (i) provides qualitative information on the programme; (ii) facilitates the interpretation of survey data; and (iii) allows for triangulation or verification of survey data. In addition, such complementary data should be used in the design of the survey. Together, survey and complementary data can identify the need for strategic changes and help address programmatic weaknesses.

As applicable for their contexts, programme managers may consider collecting complementary data from the following areas:

- **Salt industry:** This analysis requires data from the following areas: (i) the percentage of salt (iodized and non-iodized) that is imported versus domestically produced; (ii) the percentage of salt processed by large, medium and small enterprises; (iii) the percentage of food grade salt used for food processing; (iv) the locations and brand names of domestic salt farming/production and processing enterprises (including iodization and packaging/re-packing): (v) salt distribution chains; and (vi) the types of salt produced and processed for different markets. This data serves to complement the information on brands, packaging and types of salt collected through the survey and can help explain survey results. For example, household coverage of iodized salt is often lower in areas of domestic salt farming, especially among poorer households, because these families are more likely to access salt directly from the point of production, prior to any iodization or packaging processes. In addition, small scale producers often produce cheaper, lower-quality iodized (or non-iodized) salt.
- **Processed foods:** Data is needed to identify which processed food manufacturers use iodized salt, and the extent to which these manufacturers verify the iodine content of the salt used in the production of their foods.
- **Regulatory monitoring:** Regulatory monitoring data from import, production and market levels are an important source of information for programme managers. If there is a requirement to use iodized salt in the manufacturing of processed foods, a system should be in place to assess the extent of that compliance.


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Recommendations

Design of iodine nutrition surveys

The iodization of salt used in households and food processing is the most effective and sustainable strategy for IDD control (4). The impact of salt iodization programmes is best assessed through the measurement of urinary iodine concentrations (UIC) in populations. According to global recommendations, household-level data on salt iodine content and population-based UIC data should be collected every five years (3). If changes in iodine status are expected, such as due to changes in the national salt iodization programme, a survey may be warranted even before the five-year mark has passed. Household-level surveys may also attempt to estimate the frequency of consumption of the most common processed foods and condiments containing salt. If resources allow and as dictated by local conditions, it may be programmatically useful to design surveys such that geographic areas with suspected low iodized salt coverage (such as those that are home to small-scale salt producers) can be examined in separate strata. If feasible, surveys may separately examine the iodine status of pregnant women, as there is evidence that their iodine intakes may be insufficient, even in settings where iodine intake is adequate among the general population (4). Table 1 presents recommendations for addressing general issues encountered in the design of iodine nutrition surveys.

Table 1. Recommendations for addressing common issues encountered in the design of iodine nutrition surveys

Problem	Recommendation
Surveys designed to provide nationally representative estimates are not used to detect areas of low household iodized salt coverage and/or population groups with non-optimal iodine status. The exclusive use of national-level data may hide discrepancies among different sub-groups, such as those defined by geographic region or other criteria, and therefore fail to inform important programme adjustments.	• Examine household iodized salt coverage and/or population iodine status in subnational strata or in other relevant groups, such as those defined by residence, socio-economic status, or programmatically relevant criteria (e.g., by use of salt types). • Design the survey to provide representative and precise estimates for desired strata and to allow for informative sub-group analyses.
Data on household iodized salt coverage and iodine status are often not available due to a lack of funds to undertake dedicated iodine surveys. National stand-alone surveys may be expensive and available resources may be insufficient to support such surveys.	• Seek opportunities to collect data on household iodized salt coverage and iodine status in the context of other household surveys. • Continue to consider stand-alone iodine surveys if opportunities to link to other surveys are limited and if sufficient resources are available.
School-based surveys have specific design limitations. School-based surveys offer a valuable source of data on iodine status given the vulnerability of school-age children to deficiency and the easy access to schools for population-based surveys. However, such surveys also have limitations, including: i) the inability to reflect potential differences in iodine status between school-age children and other vulnerable groups, such as pregnant women; ii) the fact that school-based surveys may not allow for the collection of data on socio-economic status and other relevant population characteristics; and iii) the fact that school-based surveys may not provide a reliable reflection of the iodine status of the general population, particularly in countries or areas where school enrolment rates are low, or where school-feeding programmes (using iodized salt) operate on a large scale.	• Continue to use school-based surveys to track population iodine status in settings where school-based surveys are the only feasible data source. If resources allow, consider conducting household-based surveys as a means of addressing the design limitations of school-based surveys. Household-based surveys may enable better data collection on the coverage of household iodized salt and on the iodine status of population groups such as pregnant or non-pregnant women. They may also allow for the collection of data required to conduct sub-group analyses and to examine other programmatically relevant factors.

Assessment of household coverage of iodized salt and measurement of salt iodine content

The 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers remains a valuable resource (3) for guiding the design of household-based surveys on iodized salt coverage and interpreting survey results. Table 2 emphasizes relevant points from that Guide and presents additional considerations to improve the assessment of household coverage of iodized salt and measurement of salt iodine content.

Table 2. Recommendations on the assessment of household coverage of iodized salt and measurement of salt iodine content

Problem	Recommendation
Rapid test kits (RTKs) are erroneously used to assess whether salt is adequately iodized. Several evaluations have shown that RTKs can accurately distinguish between iodized and non-iodized salt. However, the ability of RTKs to measure the iodine content in quantitative terms and to distinguish between iodine content in salt below and above certain cutoff levels is questionable (even when the RTK packaging suggests otherwise) (8–10).	• Do not use RTK as semi-quantitative tools given the limited ability of RTKs to measure the iodine content in quantitative terms and to distinguish between iodine content in salt below and above certain cutoff levels, • Use RTKs only to present the percentage of non-iodized versus iodized salt. To estimate the percentage of inadequately iodized, adequately iodized, or excessively iodized salt, titration or other validated quantitative assessment tools are required (11).
Surveys do not use an appropriate sample size to assess household iodized salt coverage among sub-populations in stratified analyses. Sample sizes may be too small or larger than necessary for accurate representation of the situation.	• Determine stratification requirements to assess the sub-national effectiveness of the programme and prioritize strategic approaches. • Calculate necessary sample size for household iodized salt coverage per stratum, which will be based on the expected coverage, desired precision and expected design effect. Refer to established reference documents for more information (3, 15).

Problem	Recommendation
Household surveys do not collect sufficient data on the characteristics of household salt, such as salt type, packaging, and grain type. Information on these parameters may help in the interpretation of salt iodine content.	• Collect relevant information from each household (if feasible) about the salt used and where the salt was purchased. Such information may include: type of salt packaging; brand name; and source of purchase (e.g., salt processor/farmer, wet market, village retail shop or supermarket). • Categorize the salt as processed (fine) versus raw (coarse) or powder versus crystal vs rock. Categorization is best done by laboratory staff; if this is not possible, trained field-level data collectors may undertake this classification.
Iodine in coarse salt may not be distributed homogenously and small samples (≤10g) may not yield accurate results on salt iodine content. Variation in salt iodization practices, suboptimal salt mixing, large crystal size, and high moisture content of the salt may lower the homogeneity of iodine in salt samples.	• Mix the salt in the container or packet before taking a sample, using a clean spoon. Use sample weights of 50 grams if salt is coarse and if survey settings allow for the collection of such quantities (9).
In surveys using titration or other validated quantitative assessment tools, salt with iodine content of > 0mg/kg iodine is labeled as 'iodized'. Such a definition likely overestimates the percentage of iodized salt given the variation in iodine measurements at low iodine contents.	• Interpret salt with < 5 ppm iodine as 'salt without iodine', and salt with ≥ 5 ppm iodine as 'iodized salt' (9).
The current classifications of salt into the categories of non-iodized, inadequately iodized, adequately iodized, and excessively iodized do not allow for an estimation of the contribution of iodized salt to dietary iodine intakes. This is an issue, given that the goal of salt iodization programmes is to address gaps in dietary intake of iodine.	• Provide the average salt iodine content (mg/kg) and an indication of variation (e.g., 95% confidence interval (CI)) to better estimate the additional iodine supplied through salt. Salt samples without iodine should be excluded from this calculation. See Technical Annex for more information.

Problem	Recommendation
Households without salt at the time of data collection are treated differently in the calculation of household iodized salt coverage in different population-based surveys. As a result, the denominators and therefore the coverage estimates vary across such surveys, thus complicating the interpretation of household iodized salt coverage trends over time.	• Consider excluding households without salt at the time of the survey from the denominator in calculations to determine household iodized salt coverage, as the most useful programmatic coverage indicator is the percentage of households using iodized salt among households with salt at the time of the survey**.** However, the number of households without salt at the time of data collection should be noted in the survey results along with a record of missing data (households where salt was collected but not analyzed; e.g., because there was an insufficient amount, or it was lost during transfer to the laboratory). Such households should be asked whether they have purchased salt in the last seven days. Results should be used to calculate the percentage of households not using iodized salt, as those households remain susceptible to iodine deficiency.
Surveys do not consider that more than one type of salt may be used in a household.	• Include questions in the household questionnaire on whether more than one type of salt is used, what different types of salt are used, and what the different types of salt are used for. The salt tested for iodine content should be the salt used to prepare the previous evening's meal. If no salt was used to prepare last night's meal, the surveyor may ask for a sample of the most commonly used cooking salt in the household. Responses to the additional questions about other types of salt should be taken into consideration when interpreting data on household coverage of iodized salt and when looking at associations between household coverage of iodized salt and iodine status. In cases where considerable proportions of other types of salt are used, it may be necessary to collect samples and information on more than one type of salt used in the household.

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Interpretation of household iodized salt coverage against UIC

The dramatic reduction in the number of iodine deficient countries over the last 25 years was brought about by the scale up of salt iodization programmes worldwide (1,4). To this day, the iodization of all food-grade salt used in households and food processing continues to be recognized as the most effective and sustainable strategy to prevent and control iodine deficiency disorders in populations (4). Ensuring universal access to adequately iodized salt should therefore remain an important goal of nutrition programmes, and the 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers recommends that > 90% of households should be using adequately iodized salt (3).[2]

However, the iodization of all food-grade salt is not the ultimate goal of IDD control programmes. Rather, the goal of IDD programmes is to sustainably achieve optimal iodine status among all population groups. While in many settings, the links between high household coverage of iodized salt and adequate iodine status among the general population remain strong, there are instances where population iodine status is adequate despite suboptimal household iodized salt coverage. In those settings, programme managers need to determine the feasibility, cost-effectiveness, risks and added value of further increasing the use of adequately iodized salt within households. To illustrate, in settings with a fragmented salt industry, characterized by the presence of many small-scale producers, it may not be programmatically feasible or cost-effective to expect sustainable increases in the production of adequately iodized salt. In such settings, a more appropriate strategy may be to consolidate gains made while ensuring adequate iodine status for all population groups. Specific subgroup analyses comparing mUIC against salt iodine content may also provide valuable additional insights on whether programmatic adjustments are needed. See Technical Annex for more information.

2 The Guide defines adequately iodized salt as salt containing between 15 and 40 ppm iodine at household levels.

Assessment of iodine status in population-based surveys

Historically, the mUIC has frequently been assessed through school-based surveys to estimate the iodine status of the general population. However, the mUIC among school-age children may not reflect the iodine status among pregnant women, whose iodine requirements are greater (3). Household-based surveys have been used to assess the iodine status of other demographic groups, such as non-pregnant women of reproductive age. This is important because the iodine status of women of reproductive age is also the status of women entering pregnancy, when adequate maternal iodine status is vital for fetal development. However, the iodine status of non-pregnant women may not be a good indication of the iodine status among pregnant women. A review of data sets with survey data on both non-pregnant and pregnant women indicates that when the mUIC among non-pregnant women was adequate or above requirements, approximately half of the studies indicated inadequate iodine intake in pregnant women (16). As an additional limitation, there is a lack of consensus on the optimal mUIC range for non-pregnant women of reproductive age. The 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers (3) proposes a range of 100–199 µg/L; however, the scientific basis for this recommendation is weak (17). Research is currently ongoing to better define the optimal mUIC range for non-pregnant women of reproductive age.

Programme managers should also note that it remains unclear how to best conduct sample size calculations for such surveys estimating population iodine status by measuring spot UIC. The 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers (3) presents considerations on sample size calculations for surveys attempting to estimate the proportion of households using iodized salt, while stating that 'further sample size calculations are needed if additional information is collected, such as urinary iodine […]'. However, the Guide does not provide any such additional information. A UNICEF/Programme Against Micronutrient Malnutrition (PAMM) guide published in 2000 on 'Urinary Iodine Assessment: A Manual on Survey and Laboratory Methods' provides detailed and valuable information for programme managers involved in the planning and conduct of surveys determining population iodine status (18). Similar to other previous expert guidance (15), the Manual presents power calculations using the proportion of the population with iodine deficiency as a key input. This is a severe limitation, as currently available methods using spot UIC measurements do not allow for the identification of the proportion of the population with iodine deficiency (or with iodine excess) (Table 3; see Technical Annex for more information). Given the uncertainty on how to best construct statistical power calculations for surveys determining population iodine status using spot UIC measurements, programme managers may choose to take a conservative approach and define the required survey sample sizes with methods that may lead to sample sizes that may be higher than required. This would involve starting their deliberations on required sample sizes by following the longstanding recommendation of conducting a 30-cluster survey with 30 urine specimens per cluster if only a nationally representative survey estimate (without subnational stratification) is required.[3] For subnational estimates, managers should consider using 30 clusters with 20 urine specimens per cluster for each subnational estimate as a starting point,[4] as recommended in the aforementioned UNICEF/PAMM guide. Managers may furthermore choose to slightly increase the sample size per cluster to account for potential non-response. The sample size needs for each subnational estimate should then be totalled to obtain the final survey sample size. Where resources are limited, and/or if stratification will be programmatically useful, it should be noted that smaller sample sizes can still provide programmatically useful information, however. Research indicates that around 400 urine samples per population group are required to measure the mUIC with 5% precision and 100 urine samples to measure the mUIC with 10% precision (19, 20).


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3 In large countries, more than 30 clusters may be required.

4 Based on the assumption of 50 per cent prevalence of iodine deficiency, 95% confidence level, a design effect of 1.5 and a precision value of ±5 per cent

Drawing on the latest available information, Table 3 presents recommendations on the assessment of iodine status in population-based surveys.

Table 3. Recommendations on the assessment of iodine status in population-based surveys

Problem	Recommendations
According to the 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers, a mUIC in the range 100–199 µg/L indicates 'adequate' intake and 200–299 µg/L indicates 'more than adequate' intake among school-age children. mUICs in the 'more than adequate' range have raised concerns about potentially adverse effects of high iodine intakes on normal thyroid function. However, a 2013 study assessing thyroid function and iodine status found that the mUIC range of 100–299 µg/L was not associated with any thyroid dysfunction (12).	• Based on the latest scientific evidence (12), widen the acceptable range of 'adequate' iodine intake among school-age children from 100–199 µg/L to 100–299 µg/L. Note, however, that the interpretation of mUIC ≥ 300 µg/L as 'excessive iodine intake' among school-age children remains unchanged. Also note that this widened range must not be applied to women of reproductive age. See Technical Annex for more information.
Goiter is not a sensitive indicator of the impact of salt iodization on the population, yet continues to be widely used. Goiter was measured in the past when the condition was still widespread before iodized salt programs were in place. However, thyroid size and goiter prevalence are not responsive to recent changes in iodine intake. There is also significant subjectivity in the measurement of small goiters, even when ultrasound is used (21).	• Stop assessing goiter as part of routine surveys on iodine status. If goiter is assessed, provide clear justification, including how the data will be interpreted compared to UIC data, which is the best marker of dietary iodine intake.
National-level mUIC in the adequate range is incorrectly interpreted as an indication of effective control of iodine status in all parts of a given country. However, national-level estimates may mask subnational disparities in iodine status.	• Examine the mUIC in relevant sub-populations if survey design and sample size allow.[5] Consider the following stratification variables: residence (urban/rural), geographical region, socio-economic status, or level of salt iodization. Local conditions may require stratification by other variables.

5 Relevant sub-populations should be identified at the time of planning for and designing the survey and adequate sample sizes for each relevant sub-population calculated.

Problem	Recommendations
Surveys measuring UIC are inappropriately used to determine the proportion of the population with inadequate or excessive iodine intakes. In surveys presenting mUIC from spot urine collections, the proportion with urinary iodine values <100 µg/L for children (or <150 µg/L for pregnant women) is commonly falsely interpreted as the proportion of the population that is iodine deficient. Likewise, the proportion with UI values ≥300 µg/L is often interpreted as the proportion of the population with excessive iodine intakes. Such interpretations are incorrect and have led to unsubstantiated programmatic actions.	• Do not interpret the proportion of the population with UIC <100 µg/L among school-age children (or <150 µg/L for pregnant women) as being 'iodine deficient'. Likewise, do not interpret the proportion of school-age children with UIC ≥300 µg/L as the proportion with 'excessive' iodine intakes. The reason is that it is not possible with currently available methods to identify the proportion of the population with iodine deficiency or with excessive iodine intakes. As an example, a mUIC of 122 µg/L obtained from a survey among school-age children defines a population which has no iodine deficiency. It is not correct to interpret the UI values < 100 µg/L (assumed to be 40% in this example) as 'deficient'. Likewise, the 10% of school-age children with UIC ≥300 µg/L cannot be interpreted as the proportion of the population with 'excessive' iodine intakes. However, as recommended in the 2007 WHO/UNICEF/ICCIDD Guide for Programme Managers, not more than 20% of samples should be < 50 µg/L (3). See Technical Annex for more information.
The UIC distribution is often presented as a histogram using the WHO thresholds for the mUIC. This contributes to the perception that UIC values reflect the proportion of the population with deficient, optimal, or excessive iodine status. However, as has been argued above, UIC surveys cannot accurately identify the proportion of the population with deficient, optimal, or excessive iodine status.	• Present the mUIC values as point estimates (including 95% CIs). See Technical Annex for more information.

Problem	Recommendations
The mUIC is often presented by itself without a measure of sampling error. The mUIC is an estimate of the population iodine status represented by the survey sample. It is subject to sampling error and therefore, without some measure of the uncertainty resulting from sampling error, it is not possible to conclude whether the real/actual population mUIC falls above or below a recommended cut-off point.	• Calculate the 95% CI using 'bootstrapping' or other methods applicable to medians (basic guidance is available at: **www.sussex.ac.uk/its/pdfs/SPSS_Bootstrapping_22.pdf)** where sufficient capacity in statistical analysis exists. Assess whether the 95% CI includes a relevant cut-off point (e.g., 100 µg/L for school-age children). If the 95% CI does not include the cut-off, the survey mUIC is statistically different from the relevant cut-off. If the 95% CI includes the cut-off, no such statistical difference exists.
There are limitations to measuring population sodium intake from spot urine samples. As an increasing number of countries begin to align salt iodization and salt reduction programmes, including through monitoring and evaluation systems, it would be ideal to measure both UIC and urinary sodium concentrations from the same spot samples. While the use of spot urine samples helps characterize average population iodine intake, spot urine samples are less useful in characterizing average sodium intakes, and the validity of predictive equations using spot urinary sodium concentrations to predict mean 24-h sodium excretion is limited (22).	• Recognize that there may be limited utility to measuring sodium concentrations in population based surveys until methods are refined to predict mean population sodium intake from spot urine samples. The collection of 24-hr urine samples can help determine mean population sodium intake, but feasibility in survey settings is generally low.

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Technical Annex

Analysis and presentation of household iodized salt coverage data from surveys

The coverage of iodized salt at the household level is one of the most important indicators of the performance of salt iodization programmes. A suggested table shell is provided below for the presentation of survey data using quantitative tests (Table A1). These table shells should be further adapted to allow for the best representation of local survey data. If only RTK data is available, then the columns should be modified to indicate the percentage of households with 'no iodine (RTK negative)' and 'any iodine (RTK positive)'.

Table A1. Household iodized salt coverage by relevant strata: results of quantitative salt iodine testing[1]

	Total no of households in survey	Among all households, the percentage with		Among households with tested salt, the percentage with [2]				
		Salt tested	No salt in the household	No iodine (< 5 mg/kg)	Inadequate iodine (5–14.9 mg/kg)	Adequate Iodine (15–40 mg/kg)	Excess iodine (> 40 mg/kg)	Median iodine content (mg/kg) [3]
National								
Residence								
Urban								
Rural								
Region								
Region 1								
Region 2								
Region 3								
Socioeconomic status								
Quintile 1								
Quintile 2								
Quintile 3								
Quintile 4								
Quintile 5								
Salt type[4]								
Processed (fine)								
Raw (coarse)								
Packaging								
Sealed branded package								
Sealed unbranded package								
No package/ loose								

1 Strata (e.g. urban/rural; quintiles; salt type) are illustrative and should be modified and adapted as required and as programmatically relevant.

2 While it is recommended that the definition of 'no iodine' be maintained in different settings, the definitions of inadequate, adequate, and excess iodine should be modified based on national standards.

3 Median are based only on salt samples with >5mg/kg of iodine.

4 Categories of salt type and packaging should be set based on an understanding of how the salt industry operates in a given country.

Analysis and presentation of data on iodine status

The mUIC is a good indicator of population iodine status. In school-age children, a mUIC of between 100 µg/L and 299 µg/L defines a population with no iodine deficiency. A common mistake is to assume that all individuals with a spot UIC < 100 µg/L are iodine deficient. Since dietary iodine intake and therefore UIC are highly variable from day to day, even among individuals whose average iodine intake is sufficient to maintain normal thyroid function, there will be individual days when UIC is < 100 µg/L. As a result, in populations whose average dietary iodine intake is sufficient, there will always be values < 100 µg/L; however, these values do not describe the prevalence of iodine deficiency in the population. The only available guidance with regard to low UIC values is that not more than 20% of samples should be < 50 µg/L. In summary, the two key survey statistics to report are the mUIC value of the population and the proportion of UIC values < 50 µg/L. It should be noted that currently there are no suitable measures to define the proportion of iodine deficiency in the population, but efforts are underway to develop such methodologies (23).

Figure A1 provides an example of a common, but incorrect, interpretation of UIC data. In this setting, the mUIC value is 122 µg/L, which suggests optimal iodine status. However, the presentation implies that 40% of individuals in the population have inadequate iodine intakes, which is not correct. Likewise, it is incorrect to state that 10% of the population has excessive iodine intakes.

In addition to the overall mUIC of the population, stakeholders may choose to conduct stratified analyses to identify potential variations in iodine status across subgroups. This cross-tabulation by different sub-groups helps to identify where there are disparities and where programme efforts may need to be focused and resources targeted (see Table A2 and Figure A2).

Figure A1. Inappropriate interpretation of UIC data as a measure of population iodine status

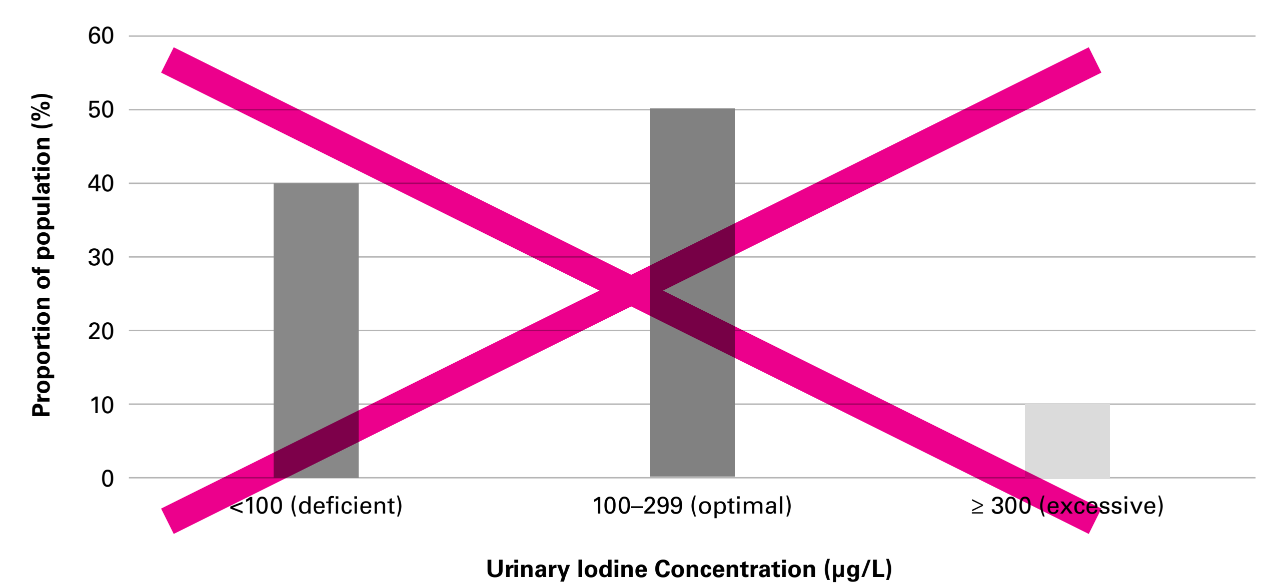


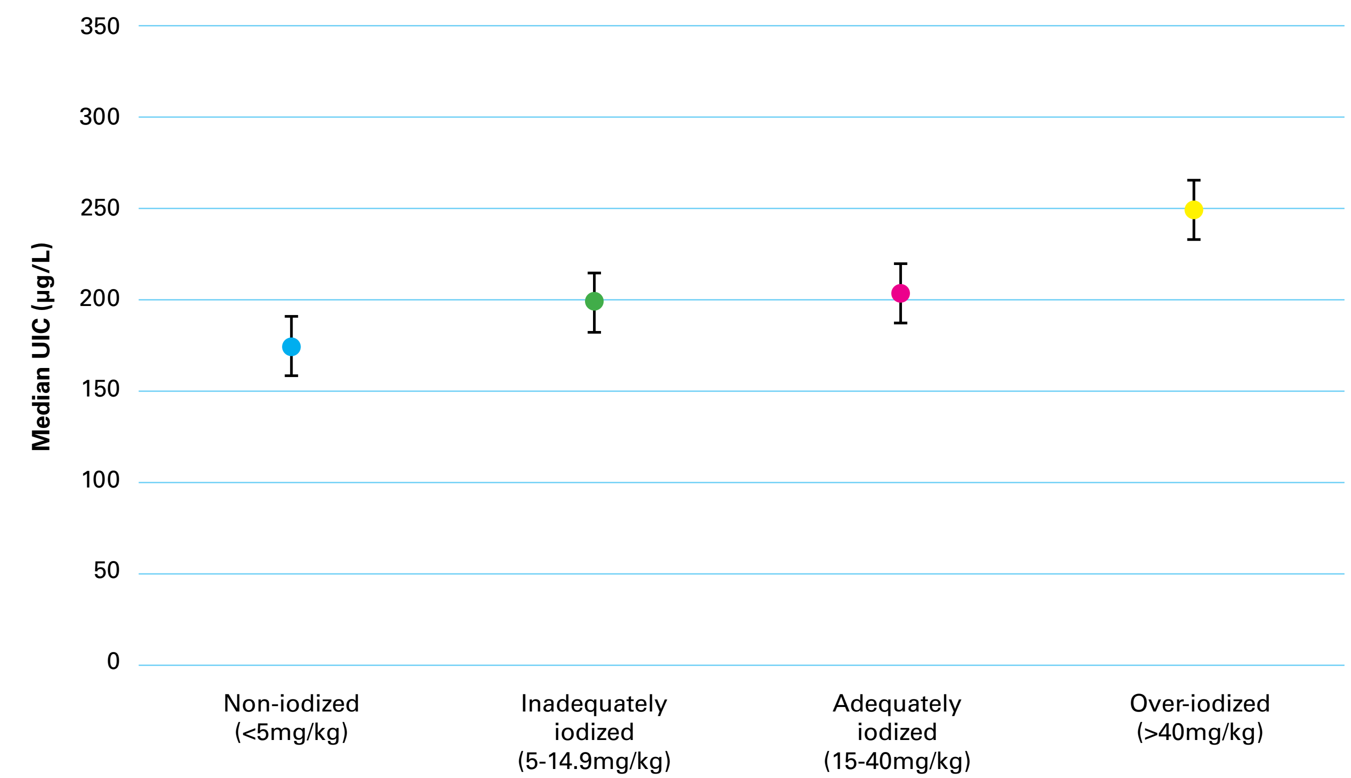
Table A2. Suggested sub-group analysis for household-based surveys on population iodine status[5]

Variable	Purpose
By household iodine content[6]: • Non-iodized (<5mg/kg); • Inadequately iodized (5–14.9mg/kg); • Adequately iodized (15–40mg/kg); • Over-iodized (>40mg/kg).	To clarify whether there is an association between iodine status and the level of iodine in household salt. Associations between iodine intake and salt iodine content can be used to advocate for strengthened regulatory monitoring, particularly if adequate iodine status is only achieved in households consuming adequately iodized salt. Where no association is observed, it may be that household salt is not the major dietary source of salt (and iodine), in which case it would be important to include complementary information about the consumption of salt in processed foods and the use of iodized salt in those foods in future monitoring.
By residence or geographic locations: • Urban vs. rural • Regions or provinces	To examine the association between iodine status and residence/ location in order to identify geographic locations with poor iodine status.
By socio economic status: • Richest quintile • Fourth quintile • Middle quintile • Second quintile • Lowest quintile	To examine a potential link between iodine status and socio-economic status. Poorer populations may have lower iodine status because they are likely to have access to salt with lower or no iodine content and/or may be more dependent on household salt as the major dietary salt source (as opposed to processed foods). Such a finding should lead to further investigation of dietary salt sources and factors inhibiting their adequate iodization.
By other programmatically relevant criteria such as in salt producing versus non-salt producing areas	To consider additional variables that may explain differences in iodine status and may help in targeting programme efforts and resources.

5 To test whether mUIC vary across subgroup, non-parametric tests should be employed. See Figure 2 for a suggested presentation of mUIC with 95% CIs from subgroup analyses.

6 While it is recommended that the definition of 'no iodine' be maintained in different settings, the definitions of inadequate, adequate, and excess iodine should be modified based on national standards.

Figure A2. Sample figure to display the association between household salt iodine content and iodine status (measured as median UIC) among school-age children[7]



7 A mUIC between 100 and 200 µg/L indicates adequate iodine status. mUICs are presented with 95% CIs. While it is recommended that the definition of 'no iodine' be maintained in different settings, the definitions of inadequate, adequate, and excess iodine should be modified based on national standards.

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