Rapid Test Kits (RTKs) can only provide a 'yes or no' on whether salt contains iodine but cannot assess salt iodine content

One of the most remarkable public health successes during the past two decades has been the worldwide increase in the consumption of iodized salt and the accompanying reduction in iodine deficiency. In 2014, UNICEF estimated that over 75% of households in the world were using iodized salt (1).

Early efforts that led to this success included advocacy and technical support to establish iodization practices among the many salt producers, as well as building awareness among consumers to appreciate the value of iodized salt. As programs scaled up and became established, having a simple way to monitor the iodine content of household salt became critical. Rapid test kits (RTK), made from a simple starch solution that changes to a blue color when iodine is present in salt, quickly became the norm for household surveys that assessed coverage. Because the intensity of the blue color was related to the concentration of iodine, many surveys assessed both the presence of iodine (any color change) and adequacy of iodization (intensity of color compared to a color chart included in the kit). Iodine experts recommended household coverage with adequately iodized salt as a key indicator of success, and large-scale household surveys reported at regular intervals the percent of households using adequately iodized salt.

However, as programs grew to maturity, and more information on iodine intake (assessed as a population median urinary iodine concentration, MUIC) became reported, it became more important to understand the accuracy of the assessment of 'adequately' iodized salt (salt containing at least 15 mg of iodine per kg of salt). The standard method for quantitative assessment of salt iodine content is titration, but this requires movement of samples to a laboratory, or use of a field method such as the WYD checker—both adding to the cost of household-based surveys. Until recently, quantitative assessment was not usually included in surveys, leaving the RTK as the predominant measure for household coverage. Laboratory studies comparing the RTK with titration were encouraging, showing good agreement between the two (2). However, the practical use of the RTK in field settings added more variability, with differences in subjective interpretation of the color change among the different survey teams and even between different members of the same team. With a growing awareness of the contribution in the diet from foods manufactured with iodized salt, accurate estimation of the contribution of household salt to iodine intake has become increasingly important.

"In a recent review paper, RTK overestimated the true coverage at the 5 mg/kg and 15 mg/kg cut-off points in the majority of surveys."

A recent paper in the journal Public Health Nutrition reviews the accuracy of the RTK in field conditions from 25 surveys in which both an RTK and titration measure were included (3). The paper reviews differences between the RTK and titration in coverage estimates for salt with any iodine (>0 ppm), salt with >5 ppm (reflecting salt that has been attempted to be iodized), and truly adequately iodized salt (>15 ppm). In addition, the study compared the samples from each survey with regard to sensitivity (identification of true positives or 'Se'), specificity (identification of true negatives or 'Sp'), and positive predictive value (PPV). The paper used the % of true positives and the % false positives (1–Sp) to create a receiver operator characteristic (ROC) graph for each iodization cut-point. The ROC curves provided an overall assessment of the misclassification characteristics of the RTK compared to titration. Finally, the paper assessed the overall accuracy or agreement rate (AR) of the RTK for different levels of household salt iodine.

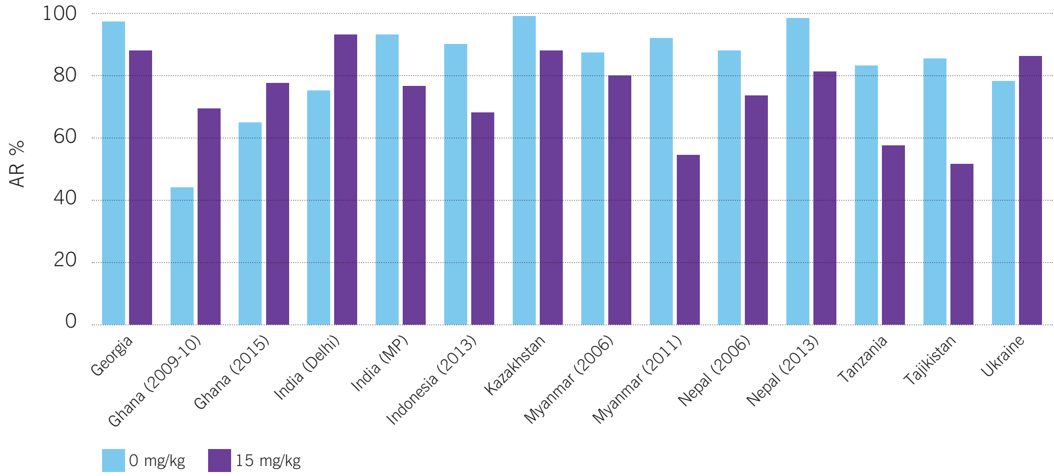
The study findings differed with regard to the different iodine levels tested (0 ppm, >5 ppm and >15ppm). With respect to coverage, the RTK overestimated the true coverage at the 5 mg/kg and 15 mg/kg cut-off points in the majority of surveys. Misclassification was common, and based on the ROC graphs, the poor performance of the RTK under field conditions at the cut-off points of 0 mg/kg and 15 mg/kg was driven mostly by the many false positive test outcomes. The accuracy of the RTK, measured by the agreement rate, was far better in determining whether salt had iodine or not, compared to whether it con-

TABLE 1 RTK performance indices in tests for adequately iodized salt (15 mg/kg) based on data from population surveys which used both methods.

	Sensitivity (Se)	Specificity (Sp)
Georgia	93.8	**5.9**
Ghana (2009-10)	**39.9**	95.8
Ghana (2015)	**85.4**	**75.4**
India (Delhi)	93.3	90.4
India (MP)	93.9	**40.4**
Indonesia (2013)	**89.6**	**38.9**
Kazakhstan	95.8	**32.2**
Myanmar (2006)	99.8	**59.6**
Myanmar (2011)	90.2	**35.7**
Nepal (2005)	**80.2**	**60.2**
Nepal (2013)	**84.8**	**68.3**
Tanzania	**65.1**	**46.8**
Tajikistan	**83.0**	**27.5**
Ukraine	**78.2**	90.1

** Values below 90% are highlighted.*

FIGURE 1 Agreement rates between the RTK and quantitative methods in identifying non iodized salt (0 mg/kg) and adequately iodized salt (15 mg/kg) using data from population surveys which used both methods.



tained an adequate amount of iodine. At 0 mg/kg, the RTK was accurate in classifying ≥90% of all salt samples tested in eight out of twenty-three surveys but achieved 90% accuracy at ≥15mg/kg in only 1 survey (India).

The study of "real world" survey conditions suggests the conclusion that the RTK is not accurate in identifying adequately iodized salt and should only be used to determine whether salt is iodized or not, thereby providing a coverage estimate for the % of households using any iodized salt. And even then, the authors would advise caution, since the AR for many surveys was too low to make an accurate assessment. Therefore, for any survey, a sub-sample should be collected for quantitative analysis that can provide accurate coverage figures for adequately iodized salt. The use of both, the RTK and a quantitative method, greatly improves the value of any population-based survey that sets out to assess household coverage. Greater efforts are needed to standardize the use and interpretation of the RTK, which may help improve accuracy.

Implications

Most countries have achieved reasonable to excellent household coverage with iodized salt, and USI may have become a lower priority. Assessments of iodine status (through MUIC) are costly, and commonly done only every 5 years or so. As a result, the % of households using adequately iodized salt is used as a proxy for adequate iodine access in the population—and thus, accuracy of this assessment is important. In the context of the increasing use of processed foods (and in many countries, the increased use of iodized salt in processed food), it is critical to better understand the iodine supply in the diet and the relative contribution of household salt. An assumption that a survey using only RTK for assessing iodine in salt provides a good estimate of total dietary iodine can be grossly misleading and allow iodine deficiency to persist for years until an assessment of iodine status is done. The inclusion of a quantitative method in all coverage surveys would be the only way to obtain an accurate estimate for iodine access for the period of several years between surveys to assess the iodine status of a population.

Assessments of the iodine content in household salt remains the simplest monitoring method to track progress with achieving USI, and moving toward elimination of IDD. With most country USI programs now more mature, a close review of RTK use and findings, and the addition of a quantitative method to any USI survey will reduce the risk of hidden persistence of inadequate dietary iodine access, and thus, intake.

References

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